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S5200D

DIGITAL TRANSMISSION TEST RECEIVER

USER MANUAL

FORM 0161-0783G

tau-tron

A UNIT OF

GENERAL SIGNAL

tau-tron
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S5200D

DIGITAL TRANSMISSION TEST RECEIVER

USER MANUAL

FORM 0161-0783G

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Phone (617)692-5100 Telex 750245 1-800-TAU-TRON (Outside MA)

WARRANTY

All Tau-Tron products are warranted against any defects in material and workmanship for a period of one year from the date of shipment. The warranty period for OEM products sold by Tau-Tron will depend on the original OEM warranty (consult factory for specific products).

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SHIPPING DAMAGE

If there are signs of damage on the outside of the carton or in the cushioning material, it should be kept until the instrument has been checked mechanically and electrically.

Procedures for checking electrical performance are found in Section 6. If there is mechanical damage or defect, or if the performance fails to meet specifications, notify the factory and follow the procedures outlined under Repair Returns in Section 8.

SAFETY INFORMATION

CAUTION

This instrument may be damaged if operated with the Line Voltage Selector on the rear-panel AC connector set for the wrong applied line voltage. (see Power, 2.2)

This insturment is designed to operate from a single phase power source, with one of the current carrying conductors at ground. Operation from power sources where both current carrying conductors are live with respect to ground is not recommended.

WARNING

To avoid dangerous electrical shock, do not perform electrical tasks when there are signs of shipping damage to any part of the instrument case.

WARNING

Before the insturment is switched on, all protective ground terminals, extension cords, autotransformers and devices connected to it should be connected to a protective grounded socket. Any interruption of the protective grounding will cause a potential shock hazard that could result in personal injury.

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Section 1, Introduction

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1.1 SCOPE

This manual provides operation, testing applications, performance, interfacing, theory of operation, and basic diagnostic information for the Tau-Tron S5200D Digital Transmission Test Receiver.

1.2 DESCRIPTION

The Tau-Tron S5200D Digital Transmission Test Receiver together with its companion instrument, the S5200D Digital Transmission Test Transmitter, form a compact test set for detailed measurements of systems operating at the DS3 transmission rate. The S5200D receiver's sophisticated microprocessor based technology provides ease of use yet powerful capabilities for a wide variety of applications including commissioning, routine maintenance, troubleshooting, long and short term system monitoring, engineering development and production testing of fiber optics, digital radio, digital multiplexers, protection switches and cable systems.

All measurements and computations are performed simultaneously with simple and direct answers provided through the 40-character front-panel display. Alphanumeric outputs give clear meaning to all results. More than 30 simultaneous measurements are made for DS3 parity, bit, BPV and signal status categories. Measurements include total errors, error-free seconds, synchronous error-seconds at different error-rate thresholds, dribbling error total and rate, logging of occurrences of a wide variety of signal status and alarm conditions from externally connected systems or site parameters. Measurement versatility is also enhanced through four different timing modes, DC operating capability, and by the IEEE-488 (GPIB) and RS-232-C interfaces. These interfaces provide test set control and measurement outputs to remote devices such as the Tau-Tron 5901 40-column printer, important in many applications. The set operates with standard B3ZS coded DS3 signals, with binary data and clock, or with binary data only and measures unframed or framed signals with a variety of data patterns including live traffic. Careful attention is given the S5200D receiver input characteristics to assure accurate and reliable measurements. Because of its extremely high sensitivity and wide dynamic range, the S5200D is guaranteed to operate at levels much higher than normal and at extremely low input levels. Also unique is the input frequency/phase timing recovery loop tailored to communications system measurement requirements and a new DS3 framing algorithm which provides fast synchronization and solid performance under very high error-rate conditions. A review of the S5200D receiver specifications will acquaint the user with the complete features.

1.3 SPECIFICATIONS

BIPOLAR INPUT	Frequency Range	44.736MHz ±1.5MHz
	Coding	Bipolar with 3 Zero Substitution (B3ZS).
	Level	
	High/Low Input	Nominal High input is 0.91V peak to 1.82V peak maximum, Nominal Low input is 13.8dB below High. (0.19V peak)
	DSX Input	Nominal DSX cross connect is High signal passed through 450 feet of 728A Cable. DSX Input equalization is for 450 feet to 900 feet of 728A Cable, typically 5 to 6dB below High. (0.48V peak)
	Sensitivity	Greater than 26dB below nominal for High and DSX input.
	Impedance	75 ohms with greater than 20dB return loss from 1 to 50MHz.
	Connector	WECo 358
BINARY DATA INPUT	Frequency Range	44.736MHz ± 1.5MHz for Binary Data Only mode. 44.736MHz ± 3.0MHz for Binary Data and Clock mode.
	Coding	Non Return to Zero (NRZ).
	Input	500mV peak-to-peak minimum, DC coupled, internally strappable AC coupled. Normal 0V threshold, Internally strappable to ECL or TTL thresholds.
	Impedance	75 ohms
	Connector	BNC
BINARY CLOCK INPUT	Frequency range	44.736MHz ± 3.0MHz squarewave.
	Input	500mV peak-to-peak minimum, AC coupled. Normal 0V threshold, internally strappable to ECL or TTL thresholds.
	Impedance	75 ohms
	Phasing	Rising clock edge in center of data ± 4ns.
	Connector	BNC

DATA PATTERNS	PRBS	Repeating pseudorandom bit sequence of 2^{15}-1 = 32767 bits.
	Short Patterns	All one's, Alternating 1100, Alternating 1010.
	Blue Signal	Automatic recognition in framed mode.
FRAMING	Framed	Bell compatible DS3 framing format. Mean time to acquire frame of 2.6 milliseconds. Mean Time to loose frame at 10^{-2} bit error-rate of more than 800 hours.
	Unframed	Measurements without DS3 framing format. Data synchronization less than 0.36 milliseconds.
MEASUREMENTS	General	All measurements made simultaneously with access thru front-panel display, RS-232-C and IEEE-488 interfaces.
BIT PARITY, and BIPOLAR MEASUREMENTS	General	Bit measurements made for data patterns in framed or unframed modes. Parity measurements made in DS3 Framed mode using DS3 parity bits. Measurements made for any data patterns including live traffic. BPV measurements made on DS3 input signal excluding legitimate B3ZS codes.
	Total Errors	9-digit total errors output plus overflow indicator.
	Current Error-Rate	Total errors per 10^8 data bits continuously measured every 10^8 bits, approximately 2.2 seconds.
	Average Error-Rate	Total errors per total received bits continuously measured over elapsed time of test. Calculation to 10^{-13} BER.
	Error-Seconds	Synchronously measured error-seconds with 7-digit output plus overflow indicator. Non-synchronous for BPV.

	Percent Error-Free Seconds	Percent calculation of total elapsed time less synchronous error-seconds relative to total elapsed time, calculation to 0.0001%.
	Threshold Error-Seconds 10^{-3}, 10^{-4}, 10^{-5}, 10^{-6}	Number of synchronous error-seconds in which rate exceeds thresholds of 10^{-3}, 10^{-4}, 10^{-5}, and 10^{-6}. Threshold of 10^{-3} invalid for parity measurements. Not measured for BPV.
	Dribbling Error-Total	Accumulated all errors when error threshold during synchronous error-second less than 10^{-6}. Not measured for BPV.
	Dribbling Error-Rate	Error-rate calculation of total dribbling errors per total elapsed time. Not measured for BPV.
STATUS MEASUREMENTS	General	Accumulation of the number of asynchronous seconds during which an event occurred.
	Signal Event Seconds	
	Signal Loss	Absence of input or input below minimum sensitivity range
	Frame Loss	Loss of DS3 frame
	Sync Loss	Loss of data pattern synchronization
	Blue Signal Detected	Detection of blue signal in DS3 frame mode independent of data pattern selection
	X-Bit Detected	Detection of logic low X-Bit.
	External Event Inputs	Detection of TTL compatible external inputs.
	A and A'	Logic High or Low TTL level triggers
	B and B'	detection.
	C	Logic Low TTL level triggers detection,
	D	internally strappable to High level.

INDICATORS	Display	LED
	Signal Status	Signal Loss, DS3 Frame Loss, Data Sync Loss, Blue Signal Detected all with Present and History status indicators. X-Bit Detected Present status, Power Loss History status indicators.
	Test Status	Time modes, Test In Process and Test Stopped indicators.
	Input Modes	Frame, Pattern and Level mode indicators.
	Control Mode	IEEE-488 Remote Indicator.
BNC SIGNAL OUTPUTS	Bit Errors Bipolar Violations Recovered Clock	75ohm source impedance 0V threshold, ±0.5V peak into 75ohms, Rear-panel connector
	Parity Errors DS3 M Sync	TTL level into 75ohm load, Rear-panel connector
STATUS OUTPUTS (D-Connector)	Signal Loss DS3 Frame Loss Data Sync Loss PRBS Sync X-Bit Detected Blue Signal Detected	TTL, 1kohm source impedance Rear-panel, 24-pin connector
	AGC	Analog voltage proportional to DS3 input signal level
	VCO	Analog control voltage of input clock recovery circuit. Buffered output, 3.6kohm source impedance. Rear-panel, 24-pin connector
EXTERNAL EVENT INPUTS (D-Connector)	A B C D	TTL compatible, Events A and B have positive and negative triggers. C and D have logic low triggers internally strappable to logic high trigger.

AUDIBLE ALARM	General	Audible alarm can be programmed to respond to Error-Rate, Signal Loss, DS3 Frame Loss or Blue Signal dectected. Power-up condition responds to Bit, Parity or BPV errors depending on total error display.
	Tone	Proportional to error-rate or steady tone for Signal Loss, Frame Loss and Blue Signal.
	Volume	Set by front-panel control
TIME MODES	Untimed	Continuous accumulated measurements and elapsed time.
	Single	All measurements are accumulated for a programmable period from 1 second up to 100 days. At end of test time, the test stops.
	Repeat	All measurements are accumulated for a programmable period from 1 second up to 100 days. At the end of the repeat time, the test automatically restarts.
	Single/Repeat	A combination of single and repeat. The single duration time is longer than the repeat time.
CLOCK	Time of Day	1-7 days, 23 hours, 59 minutes, 59 seconds. Internal battery power, clock on for more than 2 months with power off. Front-panel setting.
	Test Times	Programmable from 1 second up to 100 days. Display of test times, elapsed time, time remaining.
DISPLAY	Type	Dot Matrix, Alphanumeric
	Size	40-Character, 0.235 inches high

PRINTER OUTPUTS (with OP-02 or OP-03 only)	Error-Second	User selectable bit or parity printout for each second any error occurs, includes number of errors in err-sec, time of err-sec, and status events (Signal Loss, Data Sync Loss, DS3 Frame Loss, Blue Signal Detected, X-Bit Detected, and A, B, C, D External Events Detected).
	Err-sec Squelch	User-selectable automatic squelch of error-second printouts; Err-sec printouts suppressed when 5 consecutive seconds of squelch condition are detected. Err-sec printouts re-enabled when squelch condition is absent for five consecutve seconds. For parity err-secs, squelch condition is DS3 frame loss; For bit err-secs squelch condition is data sync loss. Printer outputs indicate time of squelch and time that error-second prints are re-enabled.
	End of Interval Summary	User-selectable automatic summary printout of bit or parity measurements at end of time tests. Summary includes: Time-of-day Elapsed time Total errors Average err-rate Total error-seconds % Error-free seconds Total Dribbling errors Dribbling error-rate Total 10^{-6}, 10^{-5}, 10^{-4}, 10^{-3} threshold errored-seconds Total status seconds (Signal Loss, DS3 Frame Loss, Data Sync Loss, Blue Signal Detected, X-Bit Detected, A, B, C, D External Events Detected).

	Immediate Summary	Summary printout on demand of bit or parity measurements. Summary formatted like End of Interval Summary.
POWER	AC	115VAC, 50 to 60Hz 100VA maximum
	DC option 08	-21 to -27VDC or -42 to -54VDC 150VA maximum (6.5A at -24V, 3.3A at -48V)
MECHANICAL	Dimensions	6.6 in. high x 13.6 in. wide by 19.8 in. deep.
	Weight	21 lb net, 26 lb shipping.

1.4 OPTIONS AVAILABLE

Binary Input, OP-01 — Binary Data and Clocks are normally 75ohm input impedance to ground, 0V threshold, 500mV peak-to-peak minimum level. Clock is AC coupled, data is DC coupled. Binary Data and clocks are internally strappable to ECL levels with 75ohm to -2V input or TTL levels. Data is strappable to AC coupled. (See Theory of Operation Section, B3ZS Input board).

IEEE-488, OP-02 — IEEE-488 Interface (GPIB). As defined in IEEE Std 488-1978, the following GPIB capabilities are implemented:

- SH1 Complete source handshake.
- AH1 Complete accepter handshake.
- T5 Basic talker, serial poll, talk only, unaddressed to talk when addressed to listen.
- TE0 No extended talker (secondary talk address) capability.
- L4 Basic listener, no listen only, unaddressed to listen when addressed to talk.
- LE0 No extended listener (secondary listen address) capability.
- SR1 Complete service request capability.
- RL2 No local lockout on remote/local capability.
- PP0 No parallel poll capability.
- DC1 Complete device clear capability.
- DT1 Complete device trigger capability.
- C0 No control capability.
- E2 Tri-state drivers are used on DIO lines to achieve maximum data transfer rates.

All S5200D receiver functions controllable from the front panel may be remotely controlled. All receiver measurements may be accessed by a GPIB controller.

RS-232-C, OP-03

Serial Output from S5200D to printer, terminal, modem, or other RS-232-C device. Switch selectable Data Rate: 110-9600 baud. Switch selectable Data Format:

- even, odd, or no parity
- 1 or 2 stop bits
- 7 or 8-bit ASCII characters (96 character set)
- 40 printable characters per line

DC Power, OP-08

Internal DC input capablity -21 to -27VDC or -42 to -54VDC 150VA, 6.25A slow-blow fuse. Unit can be powered from AC only, DC only or if AC and DC are simultaneously applied, unit will operate from AC until AC is off and then automatically switch to DC. Included with option-08 is a DC power cord.

1.5 ACCESSORIES

Accessories Supplied	AC Power Cord	3-wire grounded cord
	Spare AC Fuse	2 A slow-blow
	Mating D-Connector	For rear-panel monitor connector
	Protective Front Cover	
	Instruction Manual	

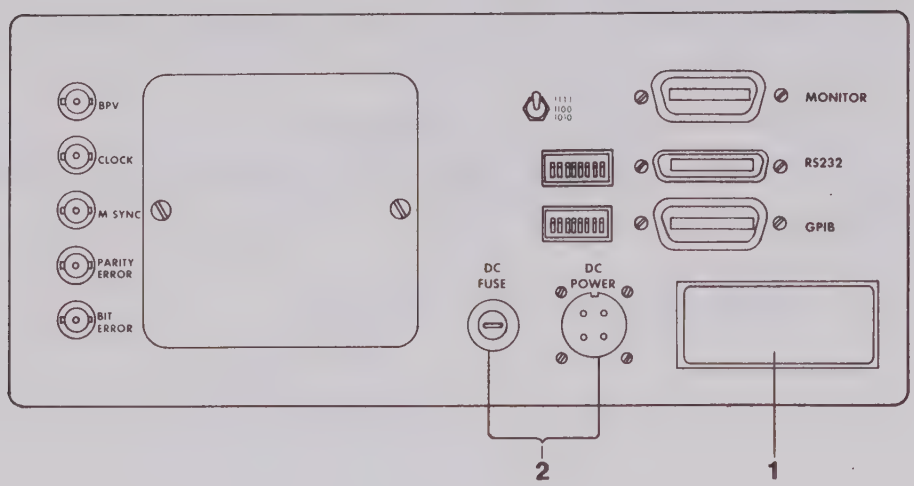
Accessories Available	S5201-1	Hard Shell Shipping Case 11 in. high x 18 in. wide x 23.5 in. long
	S5201-2	Soft Carrying Case 16 in. high x 8.5 in wide x 22 in. long
	S5201-4	Rackmount Kit, 8.75 in. high x 19 in. wide x 18.75 in. deep.

Section 2, Installation

2.1 SITE REQUIREMENTS

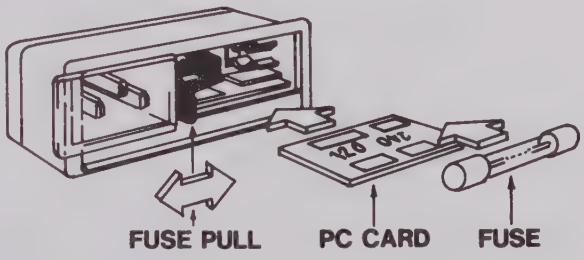
AC Power	115V ±10%, 50 to 60Hz, 100VA.
DC Power	With Option-08 DC Power only; -21 to -27V,6.5A or -42 to -54VDC, 3.3A.
Temperature	32 to 104°F (0 to 40°C).
Humidity	0 to 95%RH max at 20° C, non-condensing.
Size	13.6 in. wide x 19.8 in. deep x 6.6 in. high overall including cover, handle, and rubber feet.
Weight	21 lb. net.
Clearances	3 in. behind and 1 in. above and below.

2.2 POWER



CAUTION Be sure the line-voltage selector in the rear-panel AC connector is set for 120V before connecting to the AC line. If the incorrect range is selected, the unit could be damaged. It is also necessary to use a three-wire grounded circuit.

1. AC Power Three-wire connector accepts the 6-foot power cord supplied. Before connection, check that the 120V line-voltage range is selected and proper fuse is installed:



a. Slide cover down to left and push FUSE PULL to the left.

b. Remove fuse and check that it is a 2A slo-blo.

c. Check that the legend on the PC card in the connector reads 120V. (The card is also marked for 240V, 100V, and 220V but these ranges are not available on this unit). If it doesn't, remove the card (pull straight out), turn it around, and reinsert.

d. Rotate FUSE PULL back into its normal position and reinstall the fuse.

CAUTION Do not exceed -54VDC input. If the input exceeds -54V the DC FUSE will blow or the internal DC supply will cease functioning.

2. DC Power OP-08 Only

A DC POWER input connector and a DC FUSE holder are installed on all units but are functional only with those shipped with Option 08 DC Power. The connector is a 4-pin jack for -21 to -27V or -42 to -54VDC office-battery power and is for use with the 6-foot detachable DC power cord supplied. The fuse is 6.25A slo-blo.

Unit can be powered from AC only, DC only or if AC and DC are simultaneously applied, unit will operate from AC until AC is off and then automatically switch to DC.

Pin assignments are as follows:

A and B - GND
C and D - -VDC

The mating connector is Amphenol 14S-2SF.

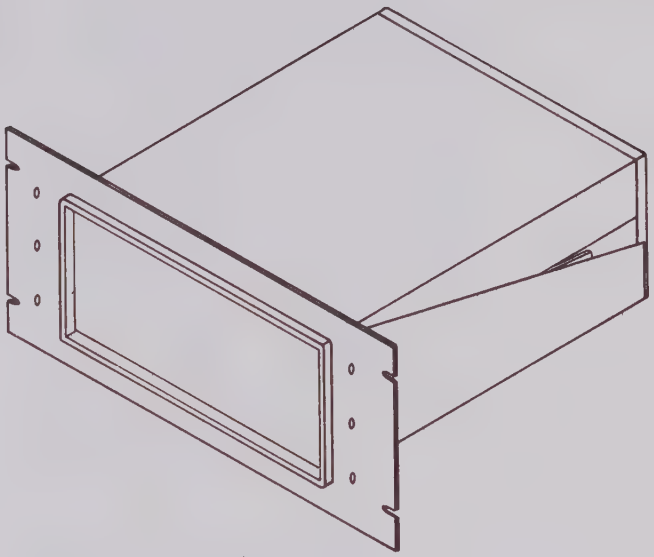
2.3 RACKMOUNTING

The unit can be rackmounted on a standard 19 in. rack by means of an S5201-4 (Rackmount Kit). Panel height is 8.75 in. and depth behind panel is 18.5 in.

a. Remove the front 2 screws from the top and bottom covers of the unit.

b. Slide the rackmount panel from the kit over the front of the unit and attach with the screws removed in step a.

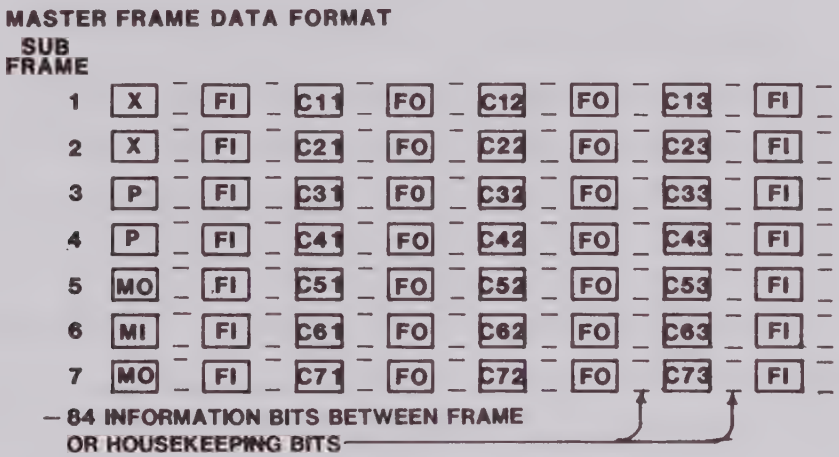
c. Mount the unit in the rack. Be sure clearances of 3 in. behind and 1 in. above and below are allowed.



Section 3, DS3 Testing

3.1 DS3 SIGNAL FORMAT

The 44.736 Mb/s DS3 signal format generated by the S5200D transmitter, MX3 and other multiplexers provide the basis for all DS3 framed measurements. Parity measurements on live traffic signals are made utilizing the DS3 format shown in the figure.


MASTER FRAME DATA FORMAT
SUB FRAME
1 X FI C11 FO C12 FO C13 FI
2 X FI C21 FO C22 FO C23 FI
3 P FI C31 FO C32 FO C33 FI
4 P FI C41 FO C42 FO C43 FI
5 MO FI C51 FO C52 FO C53 FI
6 MI FI C61 FO C62 FO C63 FI
7 MO FI C71 FO C72 FO C73 FI
– 84 INFORMATION BITS BETWEEN FRAME OR HOUSEKEEPING BITS

- M FRAME IS ALL 56 FRAME BITS AND 4704 INFORMATION BITS, TOTAL 4760 BITS,
- FRAME ALIGNMENT SIGNAL IS FI = 1, FO = 0.
- MULTI-FRAME ALIGNMENT SIGNAL IS MO,MI,MO (MO = 0,MI = 1).
- PARITY INFORMATION IS PP AND IS TAKEN OVER ALL INFORMATION BITS IN THE PRECEDING M FRAME PP = 1 IF THE SUM OF ALL INFORMATION BITS IS 1, PP = 0 IF THE SUM IS 0.
- ALARM SERVICE CHANNEL IS XX. IN ANY ONE M FRAME THE TWO X-BITS MUST BE IDENTICAL.
- STUFFING INDICATOR WORD IS THE C-BITS.
- INFORMATION BITS WITH S5200D-TX CAN BE $2^{15}-1$ PSEUDORANDOM SEQUENCE . WITH LIVE TRAFFIC IT IS SEVEN 6.312 MB/S DATA SOURCES.

There are 7 Subframes in the Master, or M Frame, each subframe consists of 8 groups of 1 housekeeping bit and 84 information bits.

The groups of 84 information bits can consist of sequences such as pseudorandom bit sequences (PRBS) or short repeating bit sequences generated by test sets, or system information such as live traffic or patterns such as "Blue Signal" codes. When live traffic is being transmitted, the 84 data bits consist of seven DS2 signals sampled twelve times. The 6.312Mb/s DS2 signal is made of four 1.544Mb/s DS1 signals. The DS1 signal can contain 24 PCM encoded voice channels, so a complete DS3 signal can contain 24x4x7=672 voice channels.

The DS3 housekeeping bits, occurring once every 85 bits, serve a variety of purposes. The 2nd, 4th, 6th and 8th housekeeping bit in each subframe is termed the F-bit or Frame Alignment signal. This four-bit sequence of F1, F0, F0, F1=1001 is identical for each subframe. This known, repeating sequence is searched for and located by demultiplexing or test equipment so that the positions of the 84 information bits and housekeeping bits can be determined.

Demultiplexing or test equipment circuitry then must locate the seven subframes. The Marker bits or M-bits are a sequence of M0, M1, M0=010 in the fifth, sixth and seventh subframe of each Master Frame which serves this purpose. The method of locating the F and M-bits is determined by the framing algorithm used in the communications equipment and is an important parameter in any system. The time to acquire DS3 Frame synchronization depends on the algorithm used and typically takes from 2 to 3 milliseconds.

Once the subframes are located, the seven stuffing indicator words corresponding to the seven multiplexed DS2 channels are known. These 3-bit words (C11, C12, C13 in subframe 1) are always all zeros or all ones indicating the absence or presence of stuffing bits necessary for the asynchronous multiplexing and demultiplexing of the DS2 channels.

Subframe location also defines the Parity (or P-bit) and X-bit locations. The P-bits in a Master Frame are used to provide a measure of error performance in the previous Master Frame. If the digital modulo-2 sum of all 7x8x84 = 4704 information bits in a Master Frame is 1 then PP=11 is output by the multiplexing or transmitting equipment in the next Master Frame. If the sum is 0 then PP=00 is output. The demultiplexing equipment or test set receiver counts the 4704 information bits in the Master Frame and compares this sum to the PP bits in the incoming format. If a transmission error has occurred in the information bits, the PP will not compare. The parity bits can be used to detect transmission errors in live traffic; however, if the error-rate is such that double or even numbers of errors occur in a Master Frame, the parity error measuring becomes invalid. This occurs at error-rates worse than $1/4704 = 2.1 \times 10^{-4}$.

The X-bits are not defined by present DS3 specifications but are normally 1, 1 and must be identical, just as the P-bits are, in a Master Frame. This requirement aids the search for the M-bits. The X-bits are used in some systems as an alarm or control channel. The S5200D receiver provides an X-bit output which can be used to log occurrences in a particular system. The X-bit input of the S5200D transmitter can be used with the receiver X-bit output to provide an auxiliary information channel. The X-bit rate is approximately 9.4kb/s.

3.2 PARITY ERROR TESTING

Use

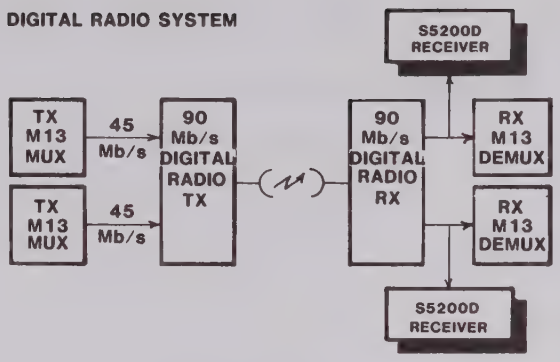
The parity-error mode is used to measure live traffic on standard data-format DS3 signals generated by MX3 or M13 multiplexers. Parity measurements can be made on single hops or multi-hops if the parity is not restored at each repeater in the multi-hop system.

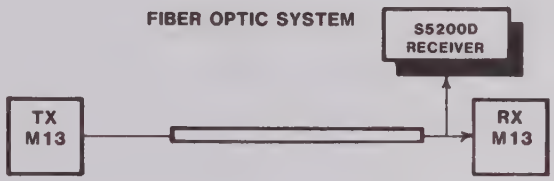
Parity Code

The multiplexer counts all the information bits in one Master Frame of 4760 bits. If the digital sum of all 4704 information bits is 1 then PP=11 in the next Master Frame. If the sum is 0 then PP=00 in the next Master Frame.

Parity Measurement

The S5200D receiver monitors the DS3 signal at the receive end of the transmission system, finds frame, and counts all of the 4704 information bits in the Master Frame. It then compares the digital sum to the PP bits in the incoming format and, if they do not agree, generates a parity error.





MASTER FRAME DATA FORMAT

SUB FRAME													
1	X	FI	C11	FO	C12	FO	C13	FI
2	X	FI	C21	FO	C22	FO	C23	FI
3	P	FI	C31	FO	C32	FO	C33	FI
4	P	FI	C41	FO	C42	FO	C43	FI
5	MO	FI	C51	FO	C52	FO	C53	FI
6	MI	FI	C61	FO	C62	FO	C63	FI
7	MO	FI	C71	FO	C72	FO	C73	FI

– 84 INFORMATION BITS BETWEEN FRAME OR HOUSEKEEPING BITS

- M FRAME IS ALL 56 FRAME BITS AND 4704 INFORMATION BITS, TOTAL 4760 BITS.
- FRAME ALIGNMENT SIGNAL IS FI = I, FO=O.
- MULTI-FRAME ALIGNMENT SIGNAL IS MO,MI,MO (MO=O,MI=I).
- PARITY INFORMATION IS PP AND IS TAKEN OVER ALL INFORMATION BITS IN THE PRECEDING M FRAME PP=I IF THE SUM OF ALL INFORMATION BITS IS I, PP=O IF THE SUM IS O.
- ALARM SERVICE CHANNEL IS XX. IN ANY ONE M FRAME THE TWO X-BITS MUST BE IDENTICAL.
- STUFFING INDICATOR WORD IS THE C-BITS.
- INFORMATION BITS WITH S5200D-TX CAN BE $2^{15}-1$ PSEUDORANDOM SEQUENCE . WITH LIVE TRAFFIC IT IS SEVEN 6.312 MB/S DATA SOURCES.

Even Number of Errors

At the transmitter, if the digital sum is 1 and one bit error is made in one detected Master Frame during transmission, the digital sum at the receiver will be 0 for that Master Frame and one parity error will be generated. Any odd number of bit errors (1,3,5,etc.) made in one Master Frame during transmission will be detected at the receiver as one parity error. Any even number of bit errors (2, 4, 6, etc.) made in one Master Frame during transmission will not be detected at the receiver.

Parity Errors vs. Bit Errors

The even/odd information from one frame is stored and compared to the parity bit received in the next frame. A difference indicates at least one data bit was in error. In general, the parity error-rate will track the bit error-rate but is limited to representing one data bit error in a frame (1 error bit divided by 4704 data bits= 2.1×10^{-4} error-rate). Thus, for error-rates greater than this, bit errors will often be greater than parity errors.

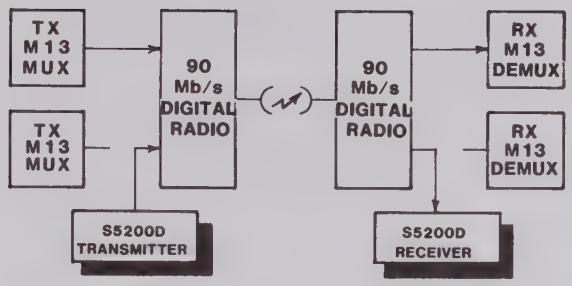
Error Multiplication Factor

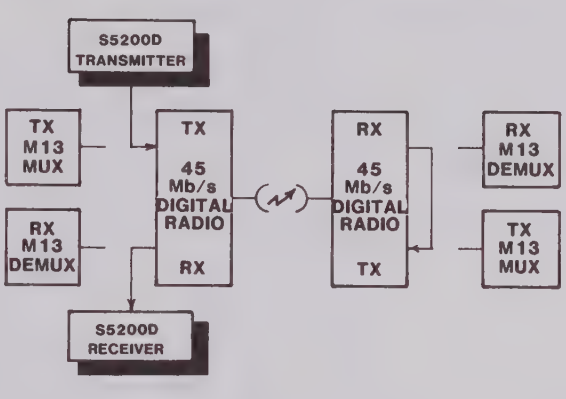
Most designers of digital systems use scramblers and descramblers and/or modulation schemes that cause a multiplication effect. This effect may result in three or more received errors from a single transmitted error. Fortunately, the error multiplication effect typically is contained within the 4704-bit frame. Usually system designers have made assurances that a statistically defined number of odd error sequences will occur so that the parity will still reflect bit errors. System manufacturers can supply the error multiplication factor for any particular system to allow the effective bit error-rate to be determined by measuring the parity error-rate.

3.3 BIT ERROR TESTING

Use

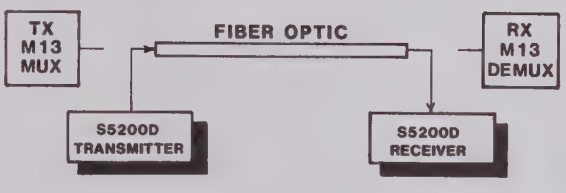
Bit-error measurements are usually made during the initial installation of digital transmission systems. They are made using either the 2^{15}-1 (32,767) bit pseudorandom pattern or short patterns generated by an S5200D transmitter. Bit measurements can be made in the framed or unframed mode, depending on system requirements.





Test Patterns

Bit error test equipment utilizes pseudorandom binary sequences or short patterns as the test pattern. The PRBS sequences, also sometimes called quasi-random sequences, are easily generated using digital shift register techniques. Their properties are such that the patterns appear to be random in nature. That is, the density of 1's and 0's in the sequence are approximately equal. Another characteristic of these sequences is that they do repeat after some number of bits. The formula which defines the length of the sequence in terms of its number of bits is given as 2^{n-1}, where n is the number of stages in the shift register generating the sequence. In the case of the S5200D, the number n equals 15 and therefore the length of the psuedormandom binary sequence before it repeats is 32,767 bits. Since the sequences do repeat, it is easy to synchronize an incoming sequence received by a receiver with a locally generated version of that same sequence.



Bit Measurements

The S5200D transmitter output is applied to the transmit end of the system and the S5200D receiver is connected to the receive end. The receiver synchronizes to the incoming pattern and compares it, bit-by-bit, to its own internal pseudorandom generator reference pattern. Any difference is counted as an error.

For systems not carrying live traffic, bit error measurements provide the most accurate assessment of system performance; however, with bit testing, several configurations are possible. Some parts of the systems do not require the DS3 format to operate properly. Inputs and outputs to some digital radio and fiber optic systems often only require the 44.736Mb/s DS3 rate and do not require framing bits. For these situations it may be desirable to utilize the unframed mode of the test set to eliminate the DS3 frame acquisition time of the receiver. This could be useful when checking hot standby switching times by observing the number of errors. For example, short patterns can be used in bit testing and a comparison of system performance between pseudorandom and short patterns can often be used in some systems to detect misalignment problems or timing recovery problems.

3.4 BIPOLAR-PULSE-VIOLATION (BPV) TESTING

Bipolar-Pulse-Violation (BPV) testing is valid for live traffic testing of cable systems and entrance links even though this type of testing has limited usefulness for DS3 systems.

The DS3 signal has a bipolar signal format. This means that all binary logical zeroes are transmitted as a OV signal and all binary logical ones are transmitted as positive or negative pulses of width equal to ½ the clock period. Bipolar coding requires that these pulses alternate in polarity. A noise impulse on a cable system or entrance link may cause a OV logical zero to be recognized as a bipolar pulse or may cause a legitimate bipolar pulse to be recognized as a OV logical zero. Either impairment will result in received bipolar pulses that do not alternate in polarity but that are of the same polarity. In this way, a performance determination can be made on a signal with a bipolar format without regard for data content or framing format.

The DS3 signal coding also requires a Bipolar 3 Zero Substitution (B3ZS) code. When 3 zeros are present in the binary data, substitution codes consisting, in part, of a bipolar violation are transmitted instead. The codes are varied to maintain the OV average DC level of the bipolar signal and are transmitted to guarantee activity on the line since some minimal activity is a requirement of some regenerative repeaters and some DS3 terminating equipment. This B3ZS coding makes BPV error measurements slightly more complex in that legitimate violation codes are not recorded as errors.

The S5200D receiver is excellent for BPV error measurements with its high input sensitivity and cable equalization optimized for 450 feet to 900 feet of 728A cable. BPV measurements of the DS3 signal have limited usefulness, however. Since the DS3 format includes a parity check, live traffic parity measurements are usually used. When bipolar pulses are passed through digital processing circuitry, the bipolar pulses are converted to binary logic levels and then processed. When these binary levels are then converted back to bipolar signals, any input bipolar violations are lost and not retransmitted. Thus, BPV measurements can only be used to test a single section of a system. Where the DS3 framing format is available, parity measurements often provide more useful results.

3.5 SYSTEM CHARACTERIZATION USING ERROR SECONDS

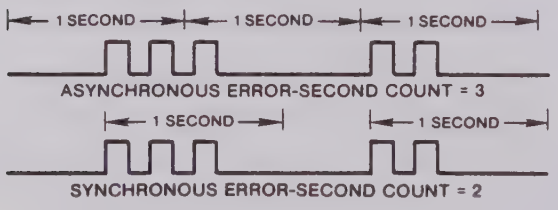
Synchronous Error Seconds

One measurement accepted as an indicator of performance is the error-second, defined as a one second period in which there are one or more errors. Specified limits for error-seconds are a requirement for some systems. Error-seconds have been used to compare systems and evaluate the effects of various parameters on system performance. In some instances the error-second measurement has been quantified by its severity. That is, if an error-second occurs in which the errors exceed a specified rate, then it is recorded as a threshold error-second. In voice grade PCM systems, error-rates exceeding 10^{-6} error bits are sometimes of interest because the error perturbations become noticable at this error-rate. At 10^{-3} error-rates voice quality becomes unacceptable. As a result, 10^{-6} and 10^{-3} threshold error-seconds would be useful for assessing performance of systems accomodating voice PCM signals.

Tau-Tron has pioneered a new way of measuring these parameters, termed the synchronous error-second measurement, that has been shown to give more consistent and accurate results useful in analysis and diagnostic measurements.

A Note About Error-Second Measurements

Two types of error-second measurements are in use, asynchronous and synchronous.



With asynchronous measurements, contiguous one-second measurements are made starting at some time independent of the errors. Any error or errors occurring during any one-second interval registers as an error-second. With synchronous measurements, the one-second measurements are triggered by the errors.

Synchronous errored-second measurements always give the lowest possible count and always give consistent counts — two test sets making the same measurement will always read the same. For these reasons they are preferred by industry and are the type used by Tau-Tron.

System Characterization

At first approximation, many digital systems can be characterized as having a combination of randomly distributed, infrequent, or dribbling type errors and occa-

sional error bursts. While all errors contribute to the overall, or average error-rate of a system, the causes of burst and dribbling errors are often quite different and quantifying these different types of errors and correlating them with other parameters can be very useful in determining their causes. Error bursts are caused by many things from power surges and propagation phenomena to intermittent connections and slamming doors; while dribbling type errors can often be related to system distortions, circuit misalignments, and other more subtle problems.

Dribbling errors, or errors that occur infrequently can be related to a system's error-rate "floor". This floor can be described as the best or lowest error-rate that a system achieves over a long period of time. Systems operating poorly may have a lower limit or error-rate floor of 1 error in 10^5 bits, or 10^{-5} error-rate. Systems operating properly may run for days without errors and have error-rate floors of 10^{-13}, 10^{-14} or even lower. In many cases the error-rate floor may be so lo that it appears to be zero. The S5200D separates dribbling errors from other burst type errors and calculates a dribbling error-rate from these errors and the elapsed time of test to give an indication of the system's present error-rate floor, if burst type errors could be eliminated. One approach to system maintenance and troubleshooting is to attack the burst type error first since they may tend to mask the lower level dribbling errors. The S5200D also quantifies the severity of the burst errors and provides a correlation between other system parameters to aid in isolating cause and effect.

Threshold Error Seconds

Since the S5200D measures error-seconds sysnchronously, it can accurately quantify the error distribution of a system by an extension of the synchronous error-second to the synchronous threshold error-second. A threshold error-second is a second in which the error-rate exceeded a specific threshold. The S5200D simultaneously measures, in addition to other parameters, the number of error-seconds in which the error-rate exceeds 10^{-3}, 10^{-4}, 10^{-5} and 10^{-6}. In this way, a system can be characterized by the severity of error bursts that cause the specific thresholds to be exceeded. These specific error thresholds have been programmed into the solid-state memory of the S5200D and if the number of errors exceeds this threshold during an error-second, then the appropriate threshold error-second totals are incremented.

Thresholds

The number of errors that causes a specific error-rate depends on the mode of operation. For example, bit error measurements in the unframed mode are made on a bit-by-bit basis over all bits in the 44.736×10^6 bit per second data stream. An error-rate worse than 10^{-3} would then require more than 44,736 errors a second. Bit measurements in the framed mode are only made on the data bits and don't include the DS3 framing bits. The framing bits occur once every 85 bits so the effective data bit rate is 84/85 x 44.736Mb/s, or 44.210Mb/s. Thus, for the framed mode, the number of bit errors must exceed 44,210 errors in a second to cause an error-rate worse than 10^{-3}.

Parity measurement thresholds are the same as DS3 framed bit measurements with the exception that since the parity bit represents 4704 data bits in a DS3 Master Frame, the parity measurement cannot accurately detect error-rates worse than 1 error per 4704 bits or 2.1×10^{-4}. Thus, 10^{-3} threshold error-seconds are invalid. A 10^{-4} threshold parity error-second would require 4421 or more errors a second.

The error-second thresholds in the S5200D have been set to consider the mode of operation and have also been adjusted to take into account the accuracy of the internal crystal controlled timing circuit which generates the synchronous one second interval. The actual error thresholds for the specific threshold error-seconds are shown below:

ERROR THRESHOLDS IN ONE SECOND PERIOD		THRESHOLD ERROR RATE
DS3 Framed Mode Bit, Parity Measurement	Unframed Mode Bit Measurements	
≥44,100	≥44,700	1×10^{-3}
≥4,410	≥4,470	1×10^{-4}
≥441	≥447	1×10^{-5}
≥44	≥44	1×10^{-6}

If these error thresholds are exceeded, then the appropriate threshold error-second counts are incremented in the S5200D.

Dribbling Errors

When errors occur during a second that do not exceed a 10^{-6} error-rate, they are termed dribbling or residual errors. The S5200D receiver maintains an exact

totalized count of all dribbling errors and also calculates the dribbling error-rate, which can be related to a system error-rate floor, if burst type errors were eliminated. If this floor is unacceptable, then another level of trouble-shooting aimed at the causes of dribbling errors is required.

Event Seconds

To aid in cause and effect diagnosis, the S5200D accumulates the number of seconds when certain parameters have occurred. Signal loss, DS3 Frame Loss, Data Sync Loss, Blue Signal detected, DS3 X-bit logic low and four TTL compatible external events are monitored. Their occurrence is recorded in separate accumulators. This provides further insight into system performance and can be useful in determining the relation between signal status, external system parameters, and error performance; particularly when the S5200D printer output is used.

Example Of Error-Second Measurement

The following shows an example of 5 error-seconds that occurred during a 12 hour overnight test. Bit measurements were made during installation prior to final system acceptance and their results are shown below.

ERROR DISTRIBUTION					
ERROR SECONDS	ERROR SECOND 1	ERROR SECOND 2	ERROR SECOND 3	ERROR SECOND 4	ERROR SECOND 5
TOTAL ERRORS	3 ERRORS	50,610 ERRORS	63 ERRORS	1 ERROR	530 ERRORS
ERROR RATE	$<1 \times 10^{-6}$	$>1 \times 10^{-3}$	$>1 \times 10^{-6}$ $<1 \times 10^{-5}$	$<1 \times 10^{-6}$	$>1 \times 10^{-5}$ $<1 \times 10^{-4}$
DRIBBLING ERRORS (ERR RATE $<10^{-6}$)	3	–	–	1	–
THRESHOLD ERROR SECONDS	–	10^{-6} thru 10^{-4}	10^{-6}	–	10^{-6} and 10^{-5}
SIGNAL STATUS EVENT SECONDS	–	FRAME LOSS AND OTHERS	–	–	–
EXTERNAL EVENTS EVENT SECONDS	–	B	A	–	A

Measurement Review

Accessing the BIT measurement TEST CATEGORY on the S5200D receiver and observing the menu of parity measurements by pushing the TEST FUNCTION button will show:

a) BIT ERR RATE=0.0E-08,TOTBIT ER=51207

The error-rate is flashing every 10^8 bits, or about 2.2 seconds indicating a current measurement. This shows the system at this time is error-free but that during the total elapsed time of the test 51,207 parity errors occurred.

b) AVG BIT ERR RATE=2.6E-08 00-12:06:51

For the 12 hours, 6 minutes and 51 seconds of testing the average error-rate was 2.6×10^{-8}.

c) % BIT ERR FREE SEC=99.9885 00-12:06:51

The 5 error-seconds resulted in 99.9885% error-free seconds of tranmission.

d) BIT ERR SEC= 5,TOTBIT ER= 51207

The 51,207 total errors occurred in 5 error-seconds.

e) BIT ErSecE-3= 1,TOTBIT ER= 51207

Parity error-rate calculations at 10^{-3} are invalid

f) BIT ErSecE-4= 1,TOTBIT ER= 51207

Of the 5 total error-seconds, 1 had an error that exceeded the 10^{-3} error-rate threshold, which is 4410 errors. Of course, this same error-second exceeded the 10^{-4} threshold also. Since the other 4 error-seconds had errors less than this threshold, we can determine that most of the 51,207 total errors occurred during this one second. We see from the example that this is error-second number 2.

g) BIT ErSecE-5= 2,TOTBIT ER= 51207

There were 2 error-seconds for which the error threshold exceeded 10^{-5}. Since we know one of these error-seconds exceeded 10^{-4} from the previous measurement, then one other error-second was worse than 10^{-5} but did not exceed 10^{-4}. From the example this is error-second number 5.

h) BIT ErSec-6= 3, TOTBIT ER= 51207

3 of the 5 error-seconds exceeded a 10^{-6} error threshold. Since 2 of these 3 exceeded 10^{-5} from the previous measurement, we know that 1 error-second was worse than 10^{-6} but did not exceed 10^{-5}. From the example this is error-second number 3.

i) BIT DribTOT= 2, TOTBIT ER= 51207

Total dribbling errors are the exact accumulation of the number of errors that occurred in error-seconds when the error-rate was better than 10^{-6}. Thus, of the 51,207 total errors only 4 errors were of the dribbling type. Most of the errors were of the burst type. These dribbling errors occurred in 2 error-seconds since there were 5 total error-seconds and 3 have thresholds worse than 10^{-6}. From the example these are error-seconds numbers 1 and 4.

j) BIT DribRATE=0.0E-12,TOTBIT ER= 51207

The dribbling error-rate calculation is a hypothetical error-rate based on the total dribbling errors for the elapsed time of test. The calculation is made to a limit of 0.1×10^{-12} or 10^{-13}. The dribbling error-rate of this system is actually 2×10^{-15}. Thus, if the burst error problems, which degraded the average system error-rate to 2.6×10^{-8}, were eliminated, then the system would perform well.

Error Distibution Estimates and Interpretation

From the above measurements we can make the following estimates about the system error distribution, which compared to the actual ones, are shown to be a very accurate representation of the actual error occurrences.

Error Seconds	Estimates of Errors	Actual	Err-Sec#
1	$\geq$44,700 but $<$ 51207*	50,610	2
2	$\geq$ 447 but $<$ 4470	530	5
3	$\geq$ 44 but $<$ 447	63	3
4	1 to 3	3	1
5	1 to 3	1	4

* Upper limit estimate for this error-second is more accurately the total errors less the minimum number of errors in each of the other error-seconds.

With one frame loss event-second recorded, we can estimate that it occurred during the error-second in which 44,700 to about 51,207 errors were made. This is interesting in that it gives some information about the system's DS3 framing ability. For voice systems this DS3 frame loss will cause Carrier Group Alarms (CGA's) in all connected channel banks.

The external event-seconds are shown in the example but there are not enough occurrences to make any cause and effect judgments. It is possible, however, to imagine similar results over a longer period for which the number of frame losses, 10^{-4} error-seconds, and event B occurrences were nearly equal. Other events may not show this correlation with errors. This may provide information that supports a cause and effect diagnosis. Printer error-second outputs can give more precise cause and effect correlation since each individual error-second can be observed.

Summary

Synchronous error-seconds, synchronous threshold error-seconds and event-seconds provide an extremely useful and accurate way of assessing system performance and provide a valuable maintenance and troubleshooting tool. The example has shown that with the summary measurements at the end of test provided by the S5200D receiver, a very accurate picture of the system error distribution can be obtained, and an approach to maintenance and troubleshooting can be determined.

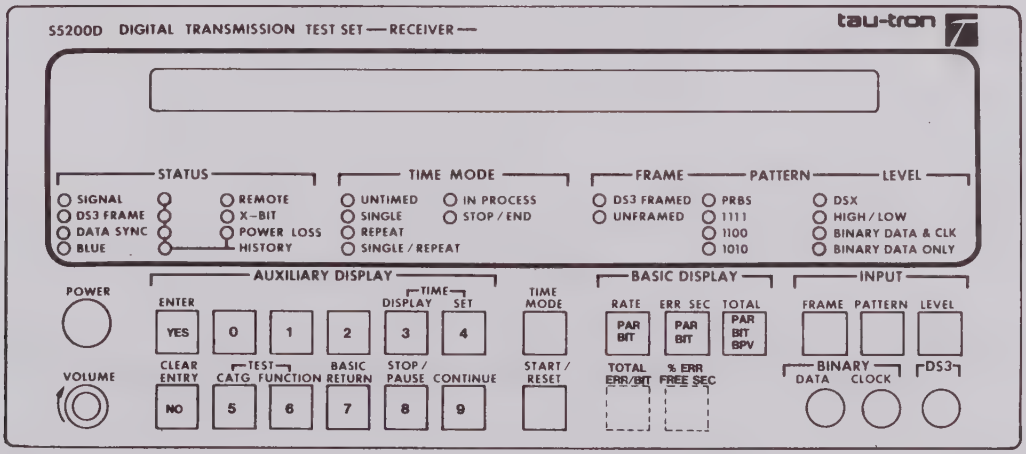
Section 4, Operation

4.1 INTRODUCTION

Most S5200D receiver functions are controllable from the front panel. Input signal and signal format, measurement display, time modes, and alarm and printer functions are selected by front-panel pushbuttons. Measurements, signal status, and test set status are all displayed on the front panel. This section describes and provides operating instructions for all front-panel controls.

Operating instructions are presented in the order the user would most likely proceed. That is, power-on instructions are presented first, then application of input signals and selection of signal characteristics, followed by measurement display selection, time mode selection, and alarm and printer selection.

Each subsection of the operating section contains a description of the function to be performed, a drawing of the front panel, and step-by-step operating procedures. The front-panel drawings highlight pushbuttons and LEDs described in the subsections. Display and LED responses to pushbutton inputs are contained in the procedures.



Multi-selection pushbuttons

Most pushbuttons are multi-selection; that is, each time they are pushed they select a different operating or display characteristic and then return to the initial characteristic in the sequence. For example, by repetitively pushing the TIME MODE button, you can select untimed, single, repeat, or single/repeat test modes. Pushing the TIME MODE button after the last choice (single/repeat) has

been selected will return the mode to the first choice in the sequence (untimed).

Multi-function pushbuttons

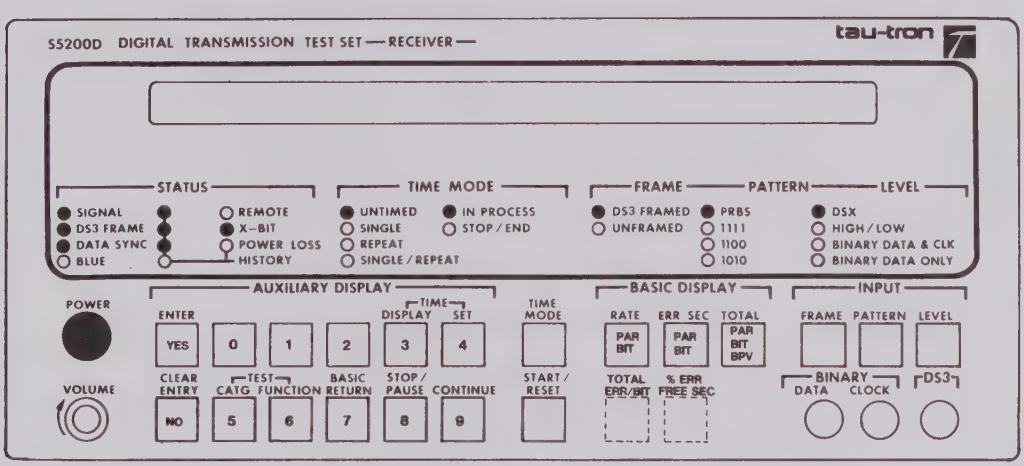
Some pushbuttons are also multi-function; that is, they control a different parameter depending upon the setting of another push-button. For example, the BASIC RETURN button normally sets the display to one of its basic modes. But if the display has been set to a mode in which a time is to be set, this same button selects the digit 7.

Prompting, automatic

The display is arranged so that the fuction of the pushbutton is largely obvious and automatic. Invalid, illegal, or meaningless commands are ignored. For many settings the display will prompt with a yes or no question (push the YES or NO button) or a blinking digit in the position that is to be set (push the desired numeric button).

4.1.1 **POWER ON**

When the S5200D receiver has been installed and plugged in as described in Section 3, power may be turned on. At power-on, the receiver will briefly execute some initial self-diagnostics. When complete, the receiver will initialize to its power-up state and begin taking measurements. When using the S5200D for the first time, it is advisable to follow the Receiver Performance Verification tests of Section 6 to familiarize the operator with set operation.



1. With power applied but with no DS3 or binary data signal plugged in, turn on the unit by pushing the POWER button.
2. Verify that the alphanumeric display is reporting parity error-rate and total parity errors. If a failure message is displayed, refer to Section 8, Service.
3. Verify that the receiver has initialized to its proper power-up state as indicated by the LEDs in the front-panel diagram. Note, the status indicators may be different if an input signal is applied. Refer to Section 8, Service, if the proper power-up state is not achieved.

4.1.2 **POWER-FAIL RECOVERY**

Power loss detection circuitry and battery-backed CMOS RAM provide the S5200D with power-fail recovery capability. Upon the detection of loss of power, the receiver saves its current set-up state in nonvolatile memory and attempts to display a power-fail message. When power is returned, the S5200D lights the POWER LOSS LED and returns itself to its previous state. Timed or untimed tests are restarted from the beginning. If set up for printer output prior to power-failure, the S5200D will resume output to the printer.

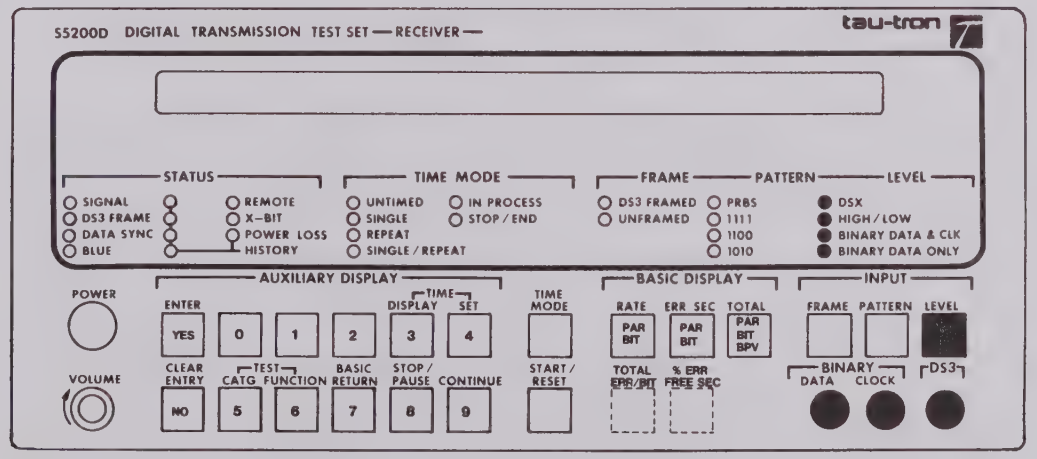
4.2 INPUT

This section discusses how to apply front-panel input signals to the S5200D receiver, including how to set up the proper input level, data pattern, and frame format.

4.2.1 LEVEL

Input level settings of the receiver are set by pushing the LEVEL button until the proper level is indicated on the four LEVEL LED indicators. DS3 signals should be connected to the WECo 358 DS3 input connector and the LEVEL button pushed to select either DSX or HIGH/LOW. In either range the extremely high sensitivity of the S5200D receiver and wide AGC range permit inputs of more than the 26dB below nominal DSX cross-connect levels and nominal high levels. The DSX LEVEL selection provides a cable equalizer permitting operation at the cross-connect point, which is a bipolar signal passed thru an effective 450 feet of 728A cable, or up to 450 feet from the cross-connect. The HIGH/LOW LEVEL has no cable equilization.

Binary data inputs can also be applied to the receiver in the BINARY DATA ONLY mode. The timing recovery is done internally by the receiver; therefore, input patterns must have sufficient activity to permit timing recovery. The all one's pattern is excluded. For the BINARY DATA and CLOCK mode, timing is needed with the data signal. In these modes, levels should exceed $\pm\frac{1}{2}$ volt peak-to-peak. DATA and CLOCK phasing should be per specifications.

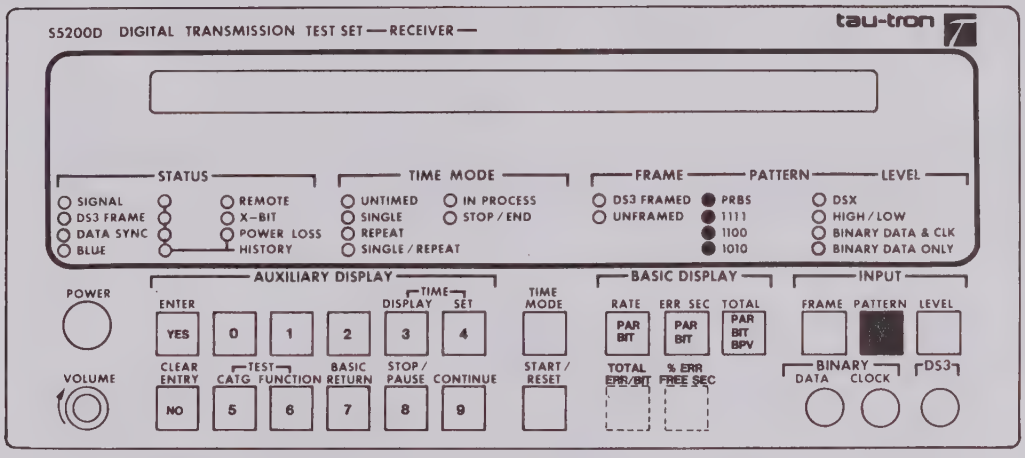


1. PUSH the LEVEL button for the proper LEVEL indication:

DSX	Input to DS3 connector
HIGH/LOW	Input to DS3 connector
BINARY DATA & CLK	Apply data to DATA connector and clock to CLOCK connector
BINARY DATA ONLY	Apply data to DATA connector

4.2.2 **PATTERN**

The receiver can be configured to receive a repeating 2^{15}-1 pseudorandom bit sequence (PRBS) or one of three short patterns (all one's, repeating 1100, or repeating 1010). The front-panel PATTERN button will select either the PRBS data pattern or one of the short patterns. The selection of the short pattern is determined by the postion of the rear-panel short pattern switch.



To select the PRBS data pattern;

1. Push the PATTERN button until the PRBS LED indicator is on.

To select a Short Pattern;

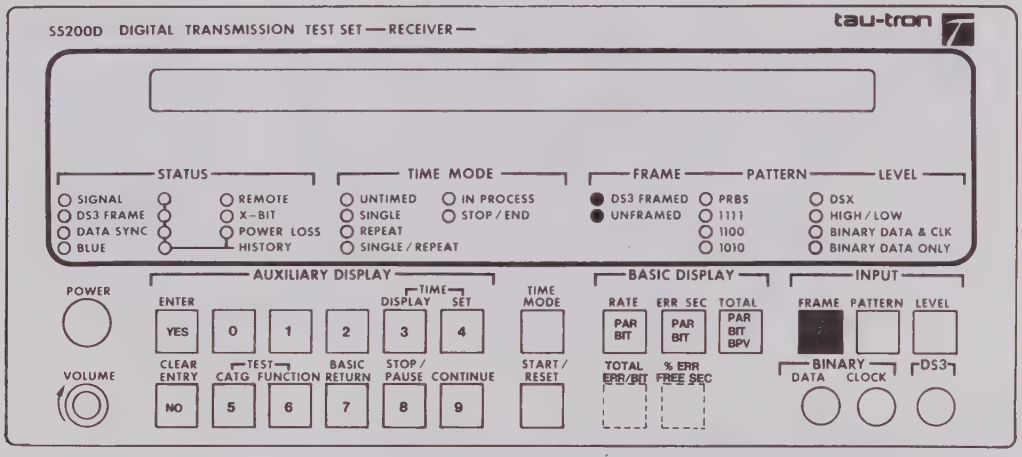
1. Set the Short Pattern switch, on the rear panel, to the desired short pattern (1111, 1100, or 1010).

2. Push the PATTERN button until the LED corresponding to the desired pattern is on. The repeating 1010 pattern, when properly framed with the standard DS3 framing format, constitutes the "Blue Signal". The receiver automatically detects the "Blue Signal" regardless of PATTERN setting.

4.2.3 **FRAME**

The receiver can be configured to receive signals with or without the DS3 framing format. In the DS3 FRAMED mode, the receiver attempts to achieve DS3 frame synchronization of the input signal. The DS3 framing algorithm in the S5200D has been specifically designed to provide fast acquistion and maintain frame synchronization under very high error environments so that measurement results will be a true indication of system performance and not be affected by test set parameters.

In the UNFRAMED mode, the DS3 frame synchronization circuitry is not utilized and only data pattern synchronization is required for proper performance.



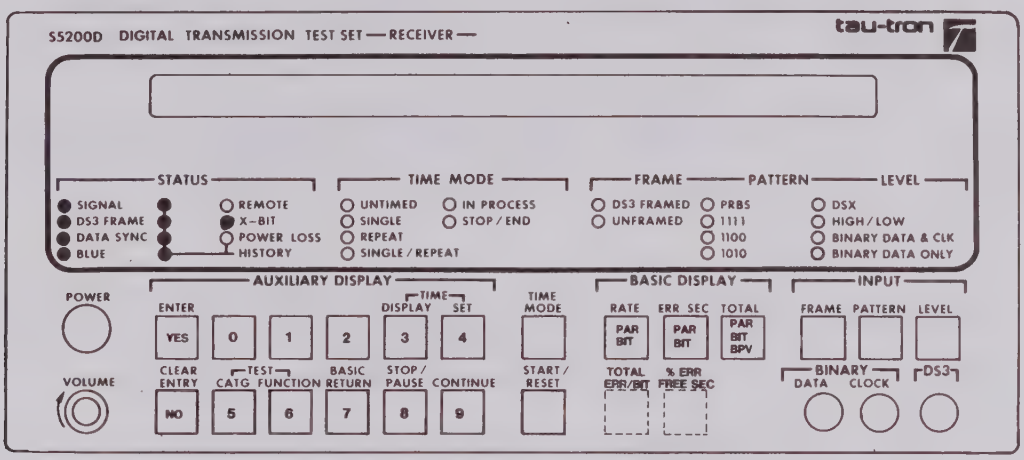
To select the proper FRAME;

1. Push the FRAME button for the proper FRAME indication:

DS3 FRAME	Used for live traffic parity measurements and all measurements on DS3 framed signals.
UNFRAMED	Used when no DS3 framing format is present.

4.2.4 SIGNAL STATUS LED'S

The front panel of the S5200D receiver has LED indicators that show present and past history status of certain signal input parameters. The history indicators can be cleared by the START/RESET button.



SIGNAL loss — Red LED indicates present status. Yellow indicates past history. Signal loss activated for no input signal.

DS3 FRAME loss — Red LED indicates present status. Yellow indicates past history. Activated when DS3 frame synchronization cannot be achieved in DS3 FRAME mode.

DATA SYNC loss — Red LED indicates present status. Yellow indicates past history. Activated when data pattern synchronization not achieved or receiver PATTERN does not correspond with input signal data pattern.

BLUE signal — Red LED indicates present status. Yellow indicates past history. Valid in DS3 FRAME mode and activated when incoming signal contains DS3 framed Blue Signal format regardless of PATTERN setting.

X-BIT — Yellow LED indicates present status. Valid in DS3 FRAME mode and activated when DS3 frame X-bit is logic low. This can occur when errors are being recorded.

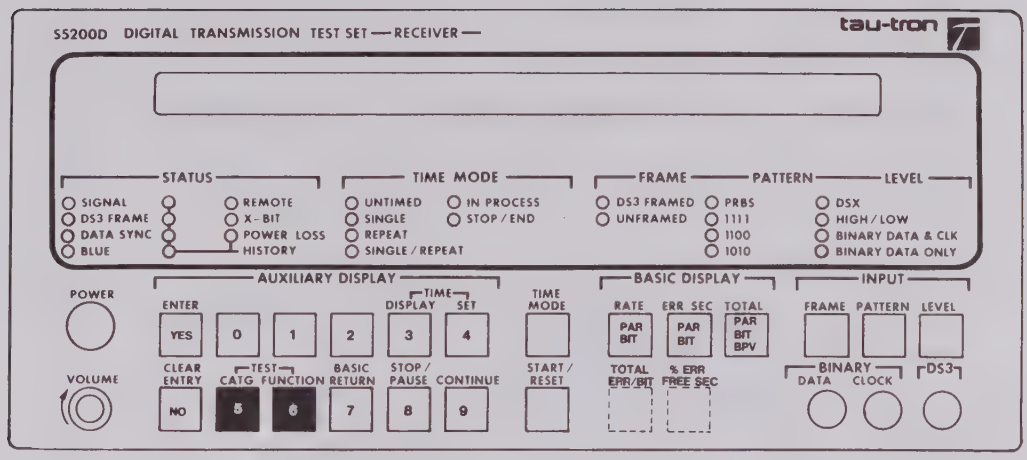
4.3 MEASUREMENTS

4.3.1 PARITY

The parity-error mode is used to measure errors in live traffic on standard data-format DS3 signals generated by MX3 or M13 multiplexers.

The following Parity measurements are available:

Total Parity-Errors	9-digit total parity-error output plus overflow indication.
Current Parity Error-Rate	Total parity-errors per 10^8 bits. Continuously measured every 10^8 bits, approximately 2.2 sec.
Average Parity Error-Rate	Total parity-errors divided by total received bits continuously measured over elapsed time of test. Calculation to 0.1×10^{-12}.
Parity Error-Seconds	Synchronously measured error-seconds with 7-digit output.
Percent Error-Free seconds	Percent calculation of error-free seconds relative to total elapsed time, calculation to 0.0001%.
Threshold Error-Seconds 10^{-4}, 10^{-5}, 10^{-6}	Number of synchronous error-seconds in which parity error-rate exceeded thresholds of 10^{-4}, 10^{-5}, and 10^{-6}. Note: Parity calculations not valid for error-rates worse than 2.1×10^{-4}.
Dribbling Error-Total	Total errors accumulated when threshold is less than 10^{-6}.
Dribbling Error-Rate	Error-rate calculation of total parity dribbling errors divided by total received bits.



Operation

1. Push the TEST CATG. button. Display will read:
   DO YOU WANT PARITY FUNCTIONS? YES or NO

   Push the YES button. Display will read:
   PAR ERR RATE= TOTPAR ER=

2. Push the TEST FUNCTION button. The display will read:
   AVG PAR ERR RATE= 00-00: 00:00 (elapsed time)
   The average parity error-rate is equal to:

$$\frac{\text{total parity errors}}{\text{bit rate x elapsed time in seconds}}$$

3. Push the TEST FUNCTION button. The display will read:
   % PAR ERR FREE SEC= 00-00:00:00 (elapsed time)
   The percent parity error-free seconds is equal to:

$$\frac{\text{elapsed time in seconds-error seconds}}{\text{elapsed time in seconds}} \times 100$$

4. Push the TEST FUNCTION button. The display will read:
   PAR ERR SEC= TOTPAR ER=

   A parity error-second is defined as a second in which there were one or more parity errors.

5. Push the TEST FUNCTION button. The display will read:
   PAR ErSec E-3=INVALID TOTPAR ER=

6. Push the TEST FUNCTION button. The display will read:
   PAR ErSec E-4= TOTPAR ER=

   A parity error-second greater than 10^{-4} is defined as a second in which there were 4410 or more errors.

7. Push the TEST FUNCTION button. The display will read:
   PAR ErSec E-5= TOTPAR ER=
   A parity error-second greater than 10^{-5} is defined as a second in which there were 441 or more errors.

8. Push the TEST FUNCTION button. The display will read:
   PAR ErSec E-6= TOTPAR ER=

   A parity error-second greater than 10^{-6} is defined as a second in which there were 44 or more errors.

9. Push the TEST FUNCTION button. The display will read:
   PAR DRIB TOT= TOTPAR ER=

   A parity dribbling error-second is defined as a second in which there were 43 or less errors. The receiver stores the count of these errors.

10. Push the TEST FUNCTION button. The display will read:
    PAR DRIB RATE= TOTPAR ER=

    The parity dribbling error-rate is equal to:

$$\frac{\text{total parity dribbling errors}}{\text{total bits received}}$$

NOTE

Some basic parity measurements included in the category-function list can be accessed in another way. This provides a direct access to the following measurements:

- Current Parity Error-Rate
- Parity Error-Seconds
- Total Parity Errors

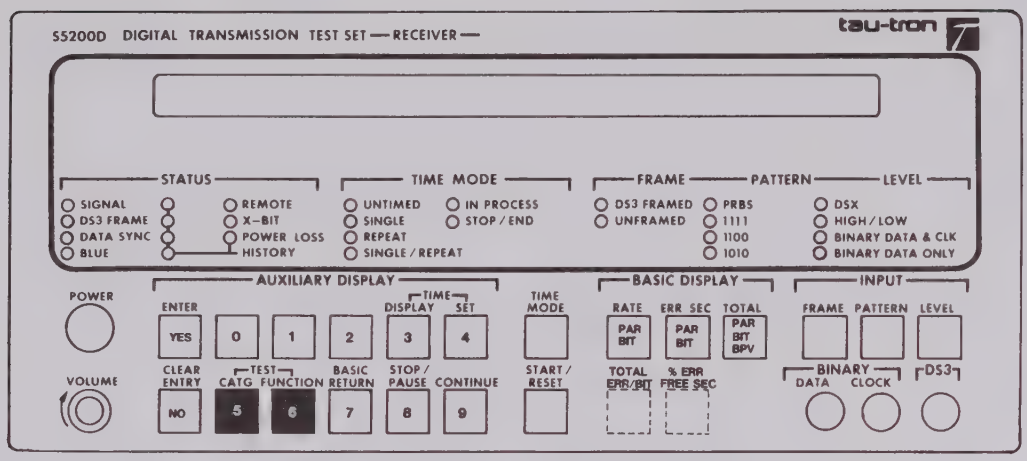
To access measurements directly, push the RATE, ERR SEC, or TOTAL buttons and observe the display for the appropriate results.

4.3.2 **BIT**

The bit-error mode is used on the installation of digital transmission systems.

The following bit-error measurements are available:

Total Bit-Errors	9-digit total bit-error output plus overflow indication.
Current Bit Error-Rate	Total bit-errors per 10^8 data bits. Continuously measured every 10^8 bits, approximately 2.2 sec.
Average Bit Error-Rate	Total bit-errors divided by total received bits continuously measured over elapsed time of test. Calculation to 0.1×10^{-12}.
Bit Error-Seconds	Synchronously measured error-seconds with 7-digit output.
Percent Error-Free Seconds	Percent calculation of elapsed time less synchronous error-seconds relative to total elapsed time, calculation to 0.0001%.
Threshold Error-Seconds 10^{-3}, 10^{-4} 10^{-5}, 10^{-6}	Number of synchronous error-seconds in which bit error-rate exceeded thresholds of 10^{-3}, 10^{-4}, 10^{-5} and 10^{-6}.
Dribbling Error-Total	Total errors accumulated when error threshold less than 10^{-6} (residual errors).
Dribbling Error-Rate	Error-rate calculation of total bit dribbling errors divided by total received bits.



Operation

1. Push the TEST CATG button until the display reads:
   DO YOU WANT BIT FUNCTIONS? YES or NO
   Push the YES button. The display will read:

   BIT ERR RATE= TOTBIT ER=

2. Push the TEST FUNCTION button. The display will read:

   AVG BIT ERR RATE= 00-00:00:00(elapsed time)

   The average bit error-rate is equal to:

$$\frac{\text{total bit errors}}{\text{bit rate x elapsed time in seconds}}$$

3. Push the TEST FUNCTION button. The display will read:

   % BIT ERR FREE SEC= 00-00:00:00(elapsed time)

   The percent bit error-free seconds is equal to:

$$\frac{\text{elapsed time in seconds-error seconds}}{\text{elapsed time in seconds}} \times 100$$

4. Push the TEST FUNCTION button. The display will read:

   BIT ERR SEC= TOTBIT ERR=

   A bit error-second is defined as a second in which there were one or more bit errors.

5. Push the TEST FUNCTION button. The display will read:

   BIT ErSec E-3= TOTBIT ERR=

A bit error-second greater than 10^{-3} is defined as a second in which there were 44,100 or more errors in the framed mode, or 44,700 or more errors in the unframed mode.

6. Push the TEST FUNCTION button. The display will read:

   BIT ErrSec E-4= TOTBIT ERR=

   A bit error-second greater than 10^{-4} is defined as a second in which there were 4,410 or more errors in the framed mode or 4,470 or more errors in the unframed mode.

7. Push the TEST FUNCTION button. The display will read:

   BIT ErrSec E-5= TOTBIT ERR=

   A bit error-second greater than 10^{-5} is defined as a second in which there were 441 or more errors in the framed mode or 447 or more in the unframed mode.

8. Push the TEST FUNCTION button. The display will read:

   BIT ErrSec E-6= TOTBIT ERR=

   A bit error-second greater than 10^{-6} is defined as a second in which there were 44 or more errors in both the framed and unframed mode.

9. Push the TEST FUNCTION button. The display will read:

   BIT DRIB TOT= TOTBIT ER=

   A bit dribbling error-second is defined as a second in which there were 43 or less errors. The receiver stores the count of these errors. Burst errors and random errors are thus kept separate.

10. Push the TEST FUNCTION button. The display will read:

    BIT DRIB RATE= TOTBIT ER=

    The bit dribbling error-rate is equal to:

$$\frac{\text{total bit dribbling errors}}{\text{total bits received}}$$

NOTE Some basic bit measurements included in the category-function list can be accessed in another way. This provides a direct access to the following measurements:

Current Bit Error-Rate
Bit Error-Seconds
Total Bit Errors

To access these measurements directly, push the RATE, ERR-SEC or TOTAL buttons and observe the display for the appropriate results.

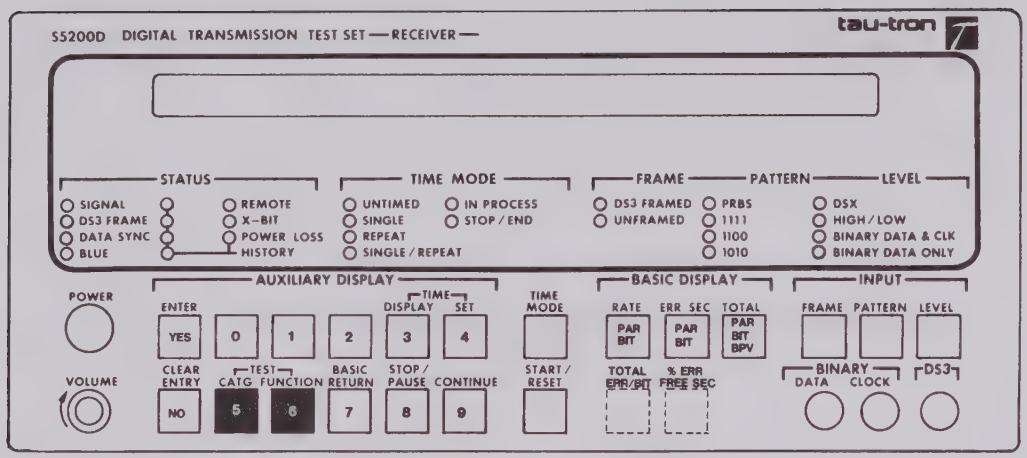
4.3.3 **BPV**

The bipolar-pulse-violation (BPV) mode can be used to measure live traffic on standard B3ZS DS3 signals, framed or unframed.

A bipolar-pulse-violation is a 1-bit with the same polarity as the preceding 1-bit.

The following BPV error measurements are available:

Total BPV Errors	9-digit total BPV output plus overflow indicator.
Current BPV Error-Rate	Total BPV errors Per 10^8 bits. Continuously measured every 10^8 bits, approximately 2.2 seconds.
Average BPV Error-Rate	Total BPV errors divided by total bits received continuously measured over elapsed time of test. Calculations to 0.1×10^{-12}.
BPV Error-Seconds	7-digit output.
Percent Error-Free Seconds	Percent calculation of error-free seconds relative to total time, calculation to 0.0001%.



Operation

1. Push the TEST CATG button until the display reads:

   DO YOU WANT BPV FUNCTIONS? YES or NO

   Push the YES button. The display will read:

   BPV ERR RATE= TOTBPV ER=

   The bipolar violation error-rate is for 10^8 bits (2.2 seconds). The rate updates every 2.2 seconds and is equal to:

   $$\frac{\text{total BPV errors in 2.2 seconds}}{10^8}$$

2. Push the TEST FUNCTION button. The display will read:

   AVG BPV ERR= 00-00:00:00 (elaspsed time)

   The average bipolar violation error-rate is equal to:

   $$\frac{\text{total BPV errors}}{\text{bit rate x elapsed time in seconds}}$$

3. Push the TEST FUNCTION button. The display will read:

   % BPV ERR FREE SEC= 00-00:00:00 (elaspsed time)

   The percent bipolar error-free seconds is equal to:

   $$\frac{\text{elapsed time in seconds - BPV error-seconds}}{\text{elapsed time in seconds}} \times 100$$

4. Push the TEST FUNCTION button. The display will read:

   BPV ERR SEC= TOT BPV ERR=

   A bipolar violation error-second is defined as a second in which there were one or more bipolar violation errors.

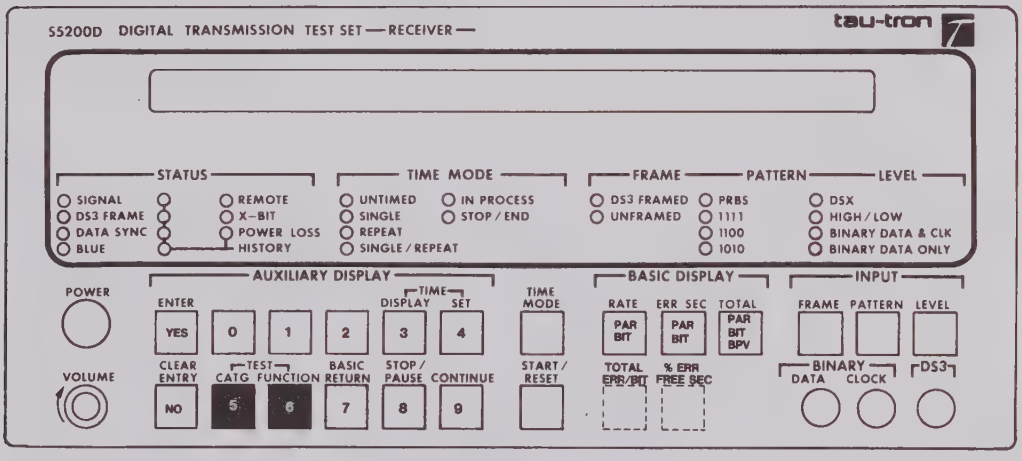
NOTE

Total BPV errors which are included in the Category-Function list can be accessed directly in another way.

To access total BPV errors directly, push the TOTAL button and observe the display for total BPV errors.

4.3.4 **STATUS**

The receiver is capable of measuring system status functions such as Signal Loss, Frame loss, Data-Sync loss (when making bit measurements), and Blue Signal Detected. (The Blue Signal is a 1010 pattern with standard DS3 framing. It is used in most digital radio transmission systems to indicate certain fault conditions. When a radio system is down between sites 1 and 2, the Blue Signal is inserted at site 2 to be transmitted to site 3. An S5200D-RX at site 3 can measure, in seconds, the length of time the system was down between sites 1 and 2). The receiver is also capable of measuring four external events labeled A, B, C, and D.



Operation

1. Push the TEST CATG button until the display reads:

   DO YOU WANT STATUS FUNCTIONS? YES or NO

2. Push the YES button. The display will read:

   SigLoss SEC= (time in seconds)

   A signal-loss second is a second in which the input signal was lost one or more times.

   The right-hand display will read total parity, bit, or bipolar violation errors, as selected by the TOTAL Basic Display button.

3. Push the TEST FUNCTION button. The display will read:

   FramLoss SEC= (time in seconds)

   A frame-loss second is a second in which the DS3 frame was lost one or more times.

4. Push the TEST FUNCTION button. The display will read:

   SyncLoss SEC= (time in seconds)

   A sync-lost second is a second in which the data sync was lost one or more times.

   Sync-loss seconds are not valid when measuring parity errors in a system carrying live traffic.

5. Push the TEST FUNCTION button. The display will read:

   BlueSig SEC= (time in seconds)

   A blue-signal second is a second in which the blue signal was detected one or more times.

6. Push the TEST FUNCTION button. The display will read:

   X-Bit Sec= (time in seconds)

   An X-Bit second is a second in which the X-Bit was a logic-0 one or more times.

   The X-Bit is a bit that occurs once per master frame of 4,760 bits in the DS3 frame format.

7. Push the TEST FUNCTION button. The display will read:

   Extrnl A SEC= (time in seconds)

   The next three times the TEST FUNCTION is pushed the display will read:

   Extrnl B SEC= (time in seconds)
   Extrnl C SEC= (time in seconds)
   Extrnl D SEC= (time in seconds)

   An external A, B, C, or D second is a second in which the external input was active one or more times.

Six TTL-compatible inputs are provided on the rear-panel MONITOR connector, one each for input A active high, input A' active low, input B' active high, input B active low, input C active low, and input D active low. These inputs can be used for alarm inputs such as multiplexer alarms, open-door alarms, etc.

4.4 TIME MODES

All measurements previously described can be made in any of the following four time modes:

Untimed: (Power-up mode). Provides continuous indication of all accumulated measurements and elapsed time.

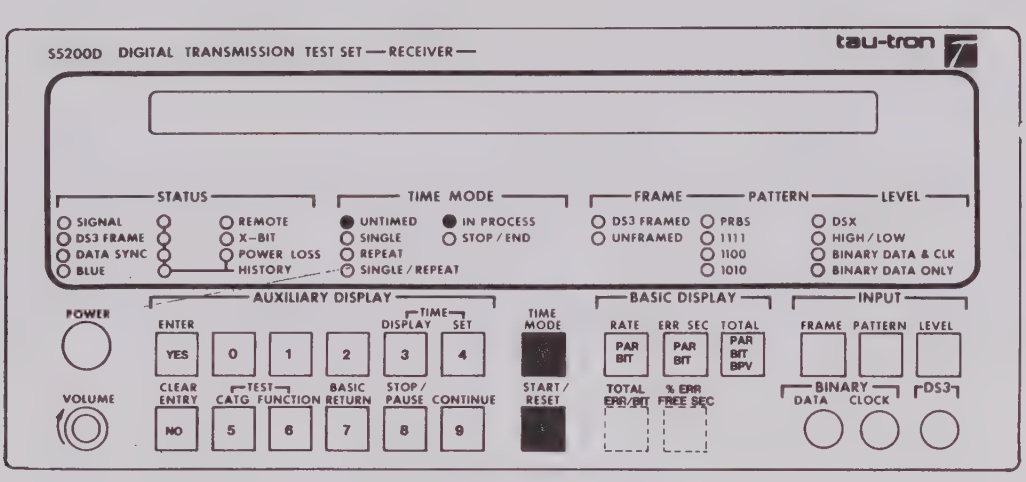
Single: Errors are accumulated over a period of time from 1 second to 100 days as selected by front-panel pushbuttons.

Repeat: Same as Single except at the end of each test time the results are cleared and a new test is started; data displayed are from last test completed.

Single/Repeat: A combination of Single and Repeat where the Single duration time is longer than the Repeat time; data displayed are from last repeat interval completed.

4.4.1 **UNTIMED**

The Untimed mode is automatically selected on power-up and provides a continuous indication of all accumulated measurements and elapsed time.



1. Push the TIME MODE button until the display reads:

   DO YOU WANT UNTIMED MODE? YES or NO

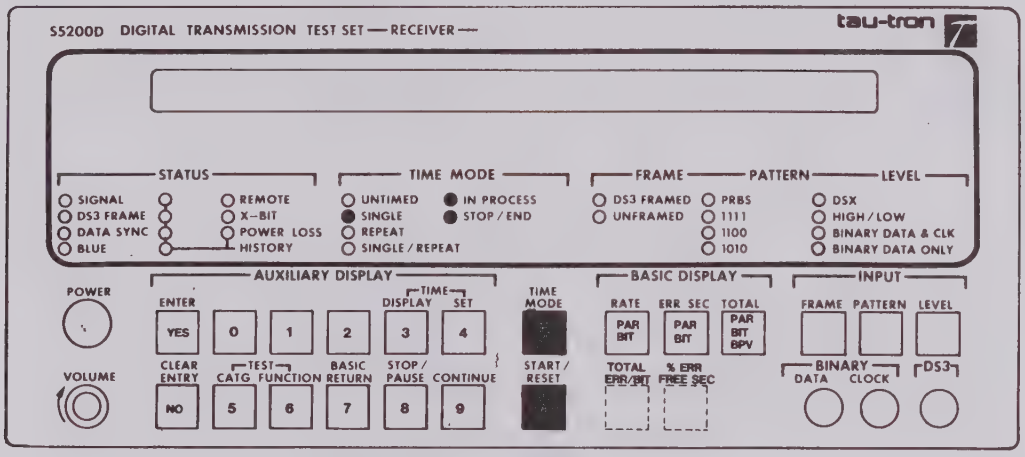
   Push the YES button. The receiver will reset all measurements to zero, the display will return to the basic display, and the IN PROCESS indicator will be lit.

2. To restart the test from zero elapsed time and zero measurement values, push the START/RESET button.

4.4.2 **SINGLE**

In the Single mode, all measurements are accumulated over a period of time that can be set in one-second increments from 1 second up to 100 days.

At the end of the preset time, the test is stopped and all data are held. The IN PROCESS indicator extinguishes and the STOP/END indicator lights.



1. Push the TIME MODE button until the display reads:

   DO YOU WANT SINGLE MODE? YES or NO

   Push the YES button. The display will read:

   SELECT + ENTER SNGL INTERVAL= 00-00:00:01

   The tens of seconds will be blinking.

2. To enter or change the Single test time, push the desired numeric button (0 through 9) for the blinking digit (tens of seconds first, then units of seconds, minutes, hours, and days). If a mistake is made, push the CLEAR ENTRY button.

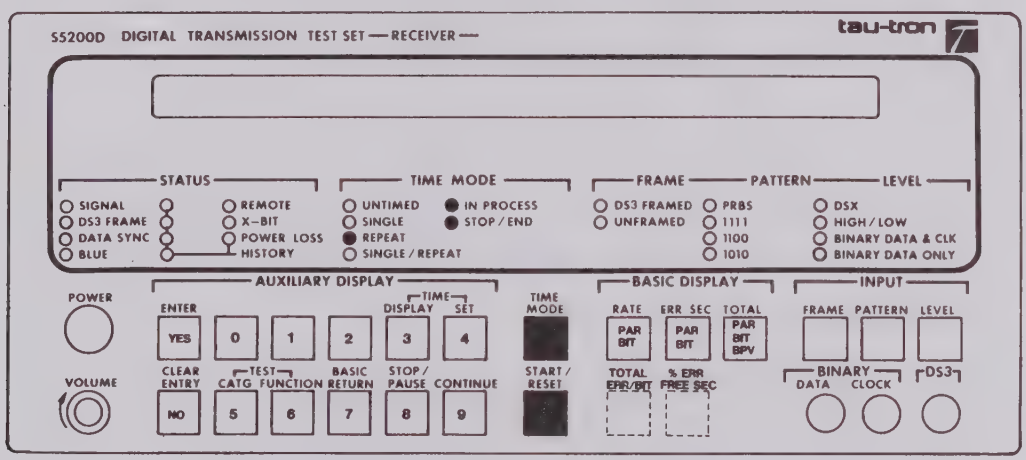
3. When the proper Single test time has been entered, push the ENTER button. The display will return to the basic measurements and the elapsed time and measurement values will reset to zero. The test will begin and the IN PROCESS indicator will light.

4. To restart the test from zero elapsed time and zero measurement values, push the START/RESET button.

4.4.3 **REPEAT**

In the Repeat mode, all measurements are accumulated over a period of time that can be set in one-second increments from 1 second up to 100 days.

At the end of the preset time, the data are stored and displayed. The accumulators are reset and a new test is started. The information that is displayed is from the last test completed.



1. Push the TIME MODE button until the display reads:

   DO YOU WANT REPEAT MODE? YES or NO

   Push the YES button. The display will read:

   SELECT + ENTER REPT INTERVAL= 00-00:00:01

   The tens of seconds will be blinking.

2. To enter or change the Repeat test time, push the desired numeric button (0 through 9) for the blinking digit (tens of seconds first, then units of seconds, then minutes, hours, and days). If a mistake is made, push the CLEAR ENTRY button.

3. When the proper Repeat test time has been entered, push the ENTER button. The display will return to the basic measurements and the elapsed time and measurement values will reset to zero. The test will begin and the IN PROCESS indicator will light. When the repeat interval

has elapsed, STOP/END will light momentarily, the display will be updated with measurements from the just completed interval, and a new test interval will begin.

4. To restart the test from zero elapsed time and zero measurement values, push the START/RESET button.

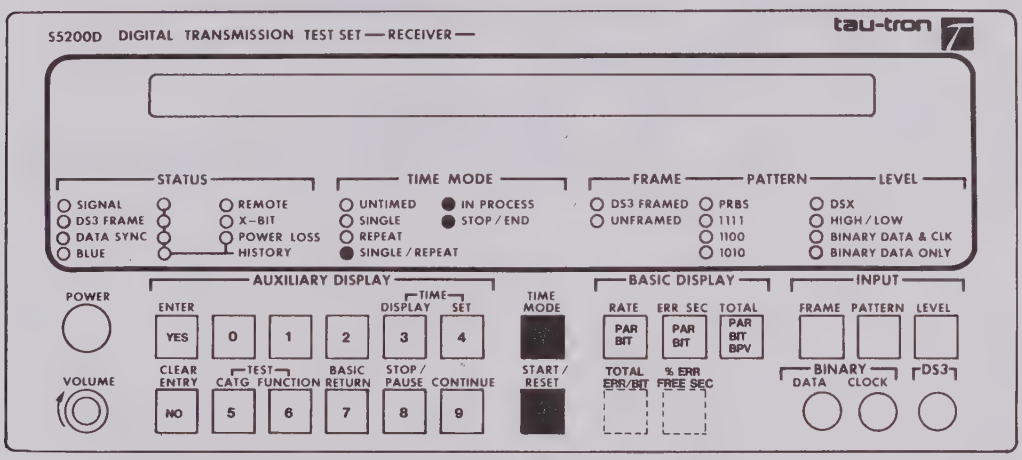
4.4.4 **SINGLE/REPEAT**

In the Single/Repeat mode, all measurements are accumulated over a period of time (the Repeat time) that can be set in one-second increments from 1 second up to 100 days.

At the end of the preset Repeat time, the data are stored and displayed. The accumulators are reset and a new test is started.

At the end of the preset Single time, the test is stopped, the STOP/END indicator lights, and the data from the last Repeat test are displayed.

When using the Single/Repeat mode, the Single time must always be longer than the Repeat time.



1. Push the TIME MODE button until the display reads:

   DO YOU WANT SNGL/REPT MODE? YES or NO

   Push the YES button. The display will read:

   SELECT + ENTER SNGL INTERVAL= 00-00:00:01

   The tens of seconds will be blinking.

2. To enter or change the Single test time, push the desired numeric button (0 through 9) for the blinking digit (tens of seconds first, then units of seconds, minutes, hours, and days). If a mistake is made, push the CLEAR ENTRY button.

3. When the proper Single test time has been entered, push the ENTER button.

   The display will read:

   SELECT + ENTER REPT INTERVAL= 00-00:00:01

   The tens of seconds will be blinking.

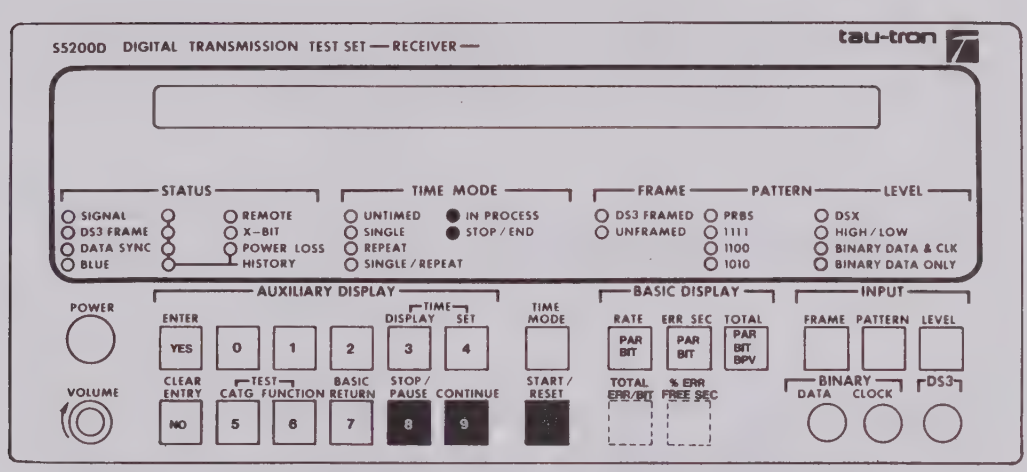
4. To enter or change the Repeat test time, push the desired numeric button (0 through 9) for the blinking digit (tens of seconds first, then units of seconds, minutes, hours, and days). The repeat interval must be shorter than the selected single interval. If a mistake is made, push the CLEAR ENTRY button.

5. When the proper Repeat test time has been entered, push the ENTER button. The display will return to the basic measurements and the elapsed time and measurement values will reset to zero. The test will begin and the IN PROCESS indicator will light.

6. To restart the test from zero elapsed time and zero measurement values, push the START/RESET button.

4.4.5 STOPPING, CONTINUING AND RESTARTING TIME MODES

The Untimed, Single, Repeat and Single/Repeat test modes can be started, stopped, or restarted with all measurement results and test time reset to zero or continued after stopping without resetting the results by utilizing the STOP/PAUSE, CONTINUE, and START/RESET buttons.



1. To reset all measurement results, and start a test in any time mode from time zero:

   Push the START/REST button and the IN PROCESS LED will light.

2. To stop a test while retaining all measurement results and maintaining the current elapsed time:

   Push the STOP/PAUSE button and the STOP/END LED will light.

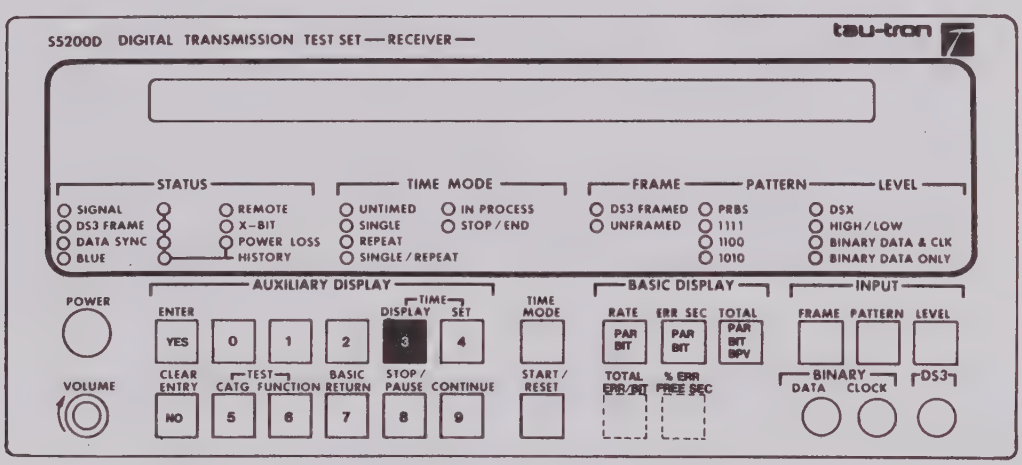
3. To continue a test after it has been stopped without resetting measurement results:

   Push the CONTINUE button and the IN PROCESS LED will light.

4.4.6 **TIME DISPLAY**

The TIME DISPLAY button allows access to time mode intervals and time-of-day without affecting the currrent test in progress. The display sequence of time intervals and time-of-day depends on the current time mode.

Time of day is always displayed in the form DD-HH:MM:SS where DD is day of week (1-7), HH is hour of day (0-23), MM is minutes of hour (0-59) and SS is seconds of minute (0-59). Time intervals (elapsed, remaining, and timed test interval) are displayed in the form DD-HH:MM:SS where DD is days (0-99), HH is hour of day, MM is minutes of hour, and SS is seconds of minute.



1. In the UNTIMED mode, push the TIME DISPLAY button. The display will read:

   TIME ELAPSED= DD-HH:MM:SS

   Push the TIME DISPLAY button again and the display will read:

   TIME OF DAY= DD-HH:MM:SS

   Push the BASIC RETURN button to return the display to the basic measurements.

2. In the SINGLE timed mode, push the TIME DISPLAY button to view the elapsed time of the single interval. The display will read:

   SNGL ELAPSED= DD-HH:MM:SS

   Push the TIME DISPLAY button again to view the time remaining in the single interval. The display will read:

SNGL REMAINING= DD-HH:MM:SS

Push the TIME DISPLAY button again to view the time of day. The display will read:

TIME OF DAY= DD-HH:MM:SS

Push the BASIC RETURN button to return the display to the basic measurements.

3. In the REPEAT timed mode, push the TIME DISPLAY button to view the elapsed time of the repeat interval in progress. The display will read:

   REPT ELAPSED= DD-HH:MM:SS

   Push the TIME DISPLAY button again to view the time remaining in the repeat interval in progress. The display will read:

   REPT REMAINING= DD-HH:MM:SS

   Push the TIME DISPLAY button again to view the selected repeat interval. The display will read:

   REPT INTERVAL= DD-HH:MM:SS

   Push the TIME DISPLAY button again to view the current time of day. The display will read:

   TIME OF DAY= DD-HH:MM:SS

   Push the BASIC RETURN button to return the display to the basic measurements.

4. In the SINGLE/REPEAT timed mode, push the TIME DISPLAY button to view the elapsed time of the single interval. The display will read:

   SNGL ELAPSED= DD-HH:MM:SS

   Push the TIME DISPLAY button again to view the time remaining in the single interval. The display will read:

   SNGL REMAINING= DD-HH:MM:SS

   Push the TIME DISPLAY button again to view the single time interval. The display will read:

SNGL INTERVAL= DD-HH:MM:SS

Push the TIME DISPLAY button again to view the elapsed time of the repeat interval in progress. The display will read:

REPT ELAPSED= DD-HH:MM:SS

Push the TIME DISPLAY button again to view the time remaining in the repeat interval in progress. The display will read:

REPT REMAINING= DD-HH:MM:SS

Push the TIME DISPLAY button again to view the selected repeat interval. The display will read:

REPT INTERVAL= DD-HH:MM:SS

Push the TIME DISPLAY button again to view the current time of day. The display will read:

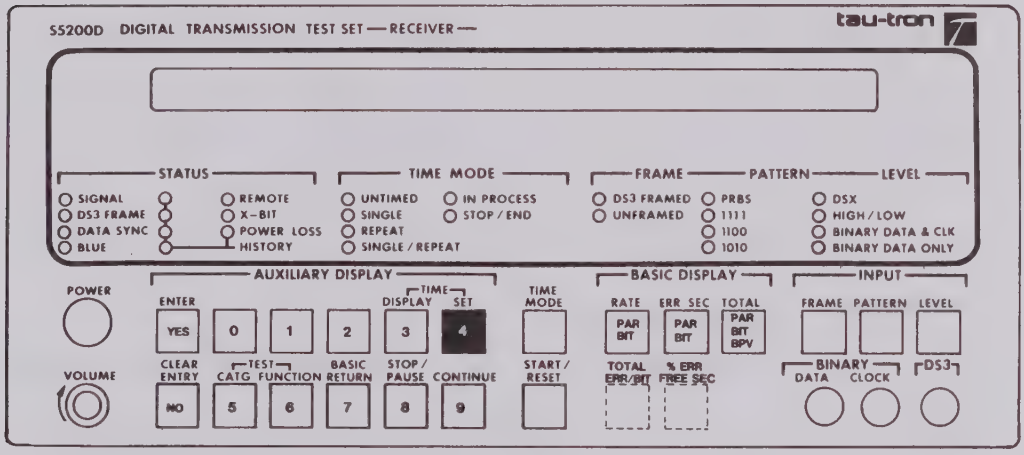
TIME OF DAY= DD-HH:MM:SS

Push the BASIC RETURN button to return the display to the basic measurements.

4.4.7 TIME OF DAY/TIME SETTING

The TIME SET button allows the user to set the S5200D's time-of-day clock or change the time interval which is currently in effect. The function of the TIME SET button depends on the current time mode of the instrument. For the four time modes, the time functions which may be set are as follows:

TIME MODE	TIME SET FUNCTION
UNTIMED	time of day
SINGLE	single interval
REPEAT	repeat interval
SINGLE/REPEAT	single and repeat intervals



The time-of-day clock is a 24-hour clock that can be set to days-of-the week (1-7), hours (0-23), and minutes (0-59). The seconds cannot be set. When the time is set, the seconds are reset to zero. The time-of-day clock will keep time for more than three months after the power is off.

1. In the UNTIMED mode, push the TIME SET button. The display will read:

   SELECT + ENTER TIME OF DAY= 00-00:00:00

The tens of minutes will be blinking. To enter or change the time of of day, push the desired numeric button for the blinking digit as follows:

NOTE If digits other than those indicated are pushed, they will not be accepted.

tens of minutes...0 through 5
minutes.....0 through 9
tens of hours.....0 through 2
hours.....0 through 9
days.....1 through 7

If a mistake is made, push the CLEAR ENTRY button. When the proper time of day has been entered, push the ENTER button. The time of day clock will be set and the display will return to the basic measurements.

2. In the SINGLE mode, push the TIME SET button to change the currently selected single interval. The current test in process will STOP and the display will read:

   SELECT + ENTER SNGL INTERVAL= 00-00:00:01

   The tens of seconds will be blinking.

   To enter or change the Single test time, push the desired numeric button (0 through 9) for the blinking digit (tens of seconds first, then units of seconds, minutes, hours, and days). If a mistake is made, push the CLEAR ENTRY button.

   When the proper Single test time has been entered, push the ENTER button. The display will return to the basic measurements and the elapsed time and measurement values will reset to zero. The test will begin and the IN PROCESS indicator will light.

3. In REPEAT mode, push the TIME SET button to change the currently selected repeat interval. The test in process will STOP and the display will read:

   SELECT + ENTER REPT INTERVAL= 00-00:00:01

   The tens of seconds will be blinking.

To enter or change the Repeat test time, push the desired numeric button (0 through 9) for the blinking digit (tens of seconds first, then units of seconds, minutes, hours, and days). If a mistake is made, push the CLEAR ENTRY button.

When the proper Repeat test time has been entered, push the ENTER button. The display will return to the basic measurements and the elapsed time and measurement values will reset to zero. The test will begin and the IN PROCESS indicator will light.

4. In the SINGLE/REPEAT mode, push the TIME SET button to change the currently selected single and/or repeat intervals. The current test in process will STOP and the display will read:

   SELECT + ENTER SNGL INTERVAL= 00-00:00:01

   The tens of seconds will be blinking.

   To enter or change the Single test time, push the desired numeric button (0 through 9) for the blinking digit (tens of seconds first, then units of seconds, minutes, hours, and days). If a mistake is made, push the CLEAR ENTRY button.

   When the proper Single test time has been entered push the ENTER button. The display will read:

   SELECT + ENTER REPT INTERVAL= 00-00:00:01

   The tens of seconds will be blinking.

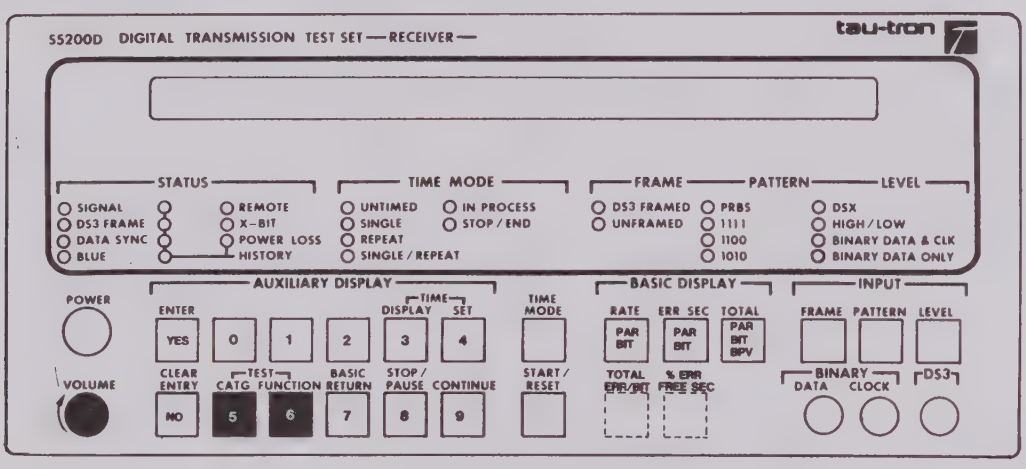
   To enter or change the Repeat test time, push the desired numeric button (0 through 9) for the blinking digit (tens of seconds first, then units of seconds, minutes, hours, and days). If a mistake is made, push the CLEAR ENTRY button.

   When the proper Repeat test time has been entered, push the ENTER button. The display will return to the basic measurements and the elapsed time and measurement values will reset to zero. The test will begin and the IN PROCESS indicator will light.

4.5 CONTROL FUNCTIONS

4.5.1 AUDIBLE ALARM

The S5200D receiver includes an audible alarm that can be programmed to respond to error-rate, signal loss, DS3 frame loss, or blue-signal detected. When programmed to respond to the error-rate, the output tone is proportional to the rate of errors counted. Volume is set by a front-panel control. On power-up, the alarm is programmed to respond to Parity error-rate, because that is the rate measurement being displayed.



Error Rate

The error-rate alarm responds to the type of error-rate displayed. If the audible alarm has been programmed to one of the status signals, it can be reprogrammed to respond to the error-rate as follows:

1. To select the Error-Rate alarm;

   Push the TEST CATG button until the display reads:

   DO YOU WANT ALARM FUNCTIONS? YES or NO

   Push the YES button.

   Push the BASIC RETURN button. The display will return to the basic measurements and the audible alarm will now respond to the type of errors being displayed.

Signal Loss

2. To select the signal loss alarm;
Push the TEST CATG button until the display reads:

DO YOU WANT ALARM FUNCTIONS? YES or NO

Push the YES button. The display will read:

DO YOU WANT SigLoss ALARM? YES or NO

Push the YES button. The display will return to the basic measurements and the audible alarm is now set to respond to an input Signal Loss.

DS3 Frame Loss

3. To select the DS3 Frame Loss alarm;
Push the TEST CATG button until the display reads:
DO YOU WANT ALARM FUNCTIONS? YES or NO

Push the YES button.

Push the TEST FUNCTION button until the display reads:

DO YOU WANT FramLoss ALARM? YES or NO

Push the YES button. The display will return to the basic measurements and the audible alarm is now set to respond to a DS3 Frame Loss.

Blue Signal

4. To select the Blue Signal alarm;
Push the TEST GATG button until the display reads:

DO YOU WANT ALARM FUNCTIONS? YES or NO

Push the YES button.

Push the TEST FUNCTION button until the display reads:

DO YOU WANT BlueSig ALARM? YES or NO

Push the YES button. The display will return to the basic measurements and the audible alarm is now set to respond to a Blue Signal.

4.5.2 **PRINTER OUTPUT**

S5200D measurements may be output to a printer by either of the two optional interfaces (GPIB or RS-232-C). This section describes the printer outputs and how to select them by front-panel controls. The details of the RS-232-C and GPIB interfaces are provided in Sections 5-3 and 5-4, respectively.

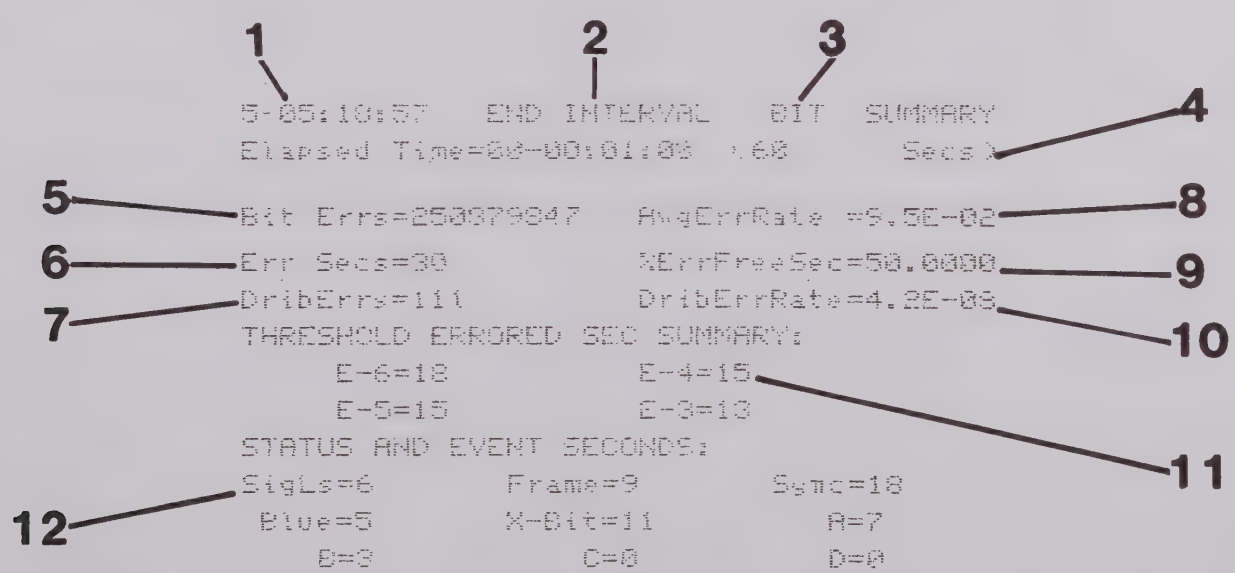
Two types of printouts are available, error-second and summary. Both can be selected to print either bit errors or parity errors. Error-second printouts occur at the end of any error-second. Summary printouts occur at the end of any timed test (Single or Repeat) or at any time on demand.

4.5.2.1 **SUMMARY PRINTOUT**

When the printer is enabled, a summary message is printed upon the completion of each timed test (Single or Repeat). The message includes the test's duration, the event-seconds for all nine internal and external events, and the following values for the type of measurement (PARITY or BIT) selected: total errors, error-seconds, average error-rate, % error-free seconds, total dribbling errors, dribbling error-rate, and threshold error-second totals for E-6, E-5, E-4, and E-3. All measurements are labeled with an appropriate mnemonic.

A summmary may be requested at any time by selecting the immediate summary print function. Bit or Parity immediate summaries may be selected independently of other print functions. The format of an immediate summary is identical to an end-of-interval summary. The first line of the summary indicates which type has been output.

A typical summary printout is shown and the fields described.



1. Time of day when summary was formatted: day of week-hour of day: minutes of hour: seconds of minute.
2. Summary type: end of interval or immediate.
3. Measurement type: bit or parity.
4. Elapsed time: days-hours: minutes: seconds and total seconds.
5. Total errors since start of elapsed interval: bit or parity total.
6. Total error-seconds since start of elapsed interval.
7. Total dribbling errors since start of elapsed interval.
8. Average error-rate= $\frac{\text{total errors}}{\text{bit rate x elapsed time in seconds}}$
9. % error-free seconds= $\frac{\text{elapsed time in seconds-error secs}}{\text{elapsed time in seconds.}} \times 100$
10. Dribbling error-rate= $\frac{\text{total dribbling errors}}{\text{bit rate x elapsed time in seconds}}$
11. Threshold error-seconds: number of error-seconds during which the error-rate exceeded 10^{-6}, 10^{-5}, 10^{-4}, or 10^{-3}. Dribbling error-seconds may be computed by subtracting the number of 10^{-6} error-seconds from the total error-seconds.
12. Status and event seconds: number of seconds during which any of the listed events were detected. These status event seconds are not synchronized to error-seconds.

4.5.2.2 **ERROR-SECOND PRINTOUT**

If the user requests an error-second printout, a message is printed upon the occurrence of each error-second of the type of error selected (Parity or Bit). The message includes time-of-day (accurate to within one second of the end of an error-second), the number of errors in that error-second, and the status of all the internal and external events (A, B, C, D, Signal Loss, DS3 Frame Loss, Data Sync Loss, Blue Signal Detected, and X-Bit Detected).

Since signal loss implies frame and data sync loss, the signal loss event masks reporting of lost frame and data sync. Typical error-second printouts are shown in the following figure.

ERROR SECOND

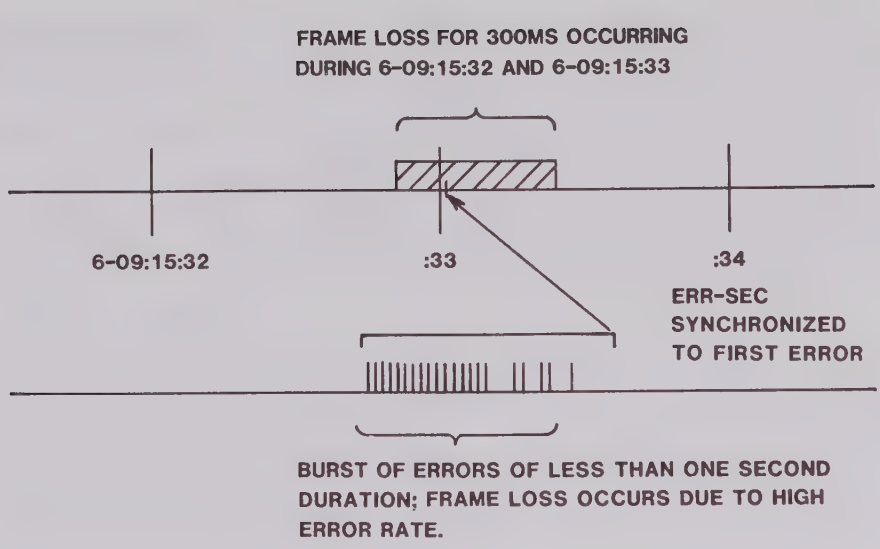
Time of Error-Sec	Bit or Par Error-Sec	Total Errors in Second 8 Digits	Frame, Data or Signal Loss	Blue Sig Det	X Bit Det	External Inputs A B C D
5-05:18:00	Bit=	5				
5-05:18:01	Bit=	2				
5-05:18:03	Bit=	3				
5-05:18:06	Bit=	4419				
5-05:18:06	Bit=	4420			X	
5-05:18:07	Bit=	377			X	
5-05:18:08	Bit=	7				
5-05:18:16	Bit=	44				
5-05:18:17	Bit=	6				
5-05:18:19	Bit=	45				
5-05:18:20	Bit=	13				
5-05:18:22	Bit=19952521,		FrmSync		X	
5-05:18:23	Bit= 4217737,		FrmSync		X	
5-05:18:26	Bit=22245734		Sync			
5-05:18:27	Bit=22245816		Sync			
5-05:18:28	Bit=20583894		Sync			
5-05:18:33	Bit=22978755		SyncBlu			
5-05:18:34	Bit=22982592		SyncBlu			
5-05:18:35	Bit=22982802		SyncBlu			
5-05:18:36	Bit=13328599		SyncBlu			
5-05:18:40	Bit=	4				
5-05:18:42	Bit=	40				
5-05:18:43	Bit=	16				
5-05:18:44	Bit=	9				
5-05:18:46	Bit=20430520,		SigLoss		X	A
5-05:18:47	Bit=11199079,		SigLoss		X	A
5-05:18:52	Bit=23877880,		SigLoss		X	A
5-05:18:53	Bit=23844502,		SigLoss		X	A
5-05:18:57	Bit=	4				
5-05:18:57	Bit=	2				B

One of the features of the S5200D is synchronous error-seconds; that is, an error-second begins with the detection of an error. All errors falling within a one second window synchronized to the beginning error are included in that error-second. Status event seconds are not synchronized to error-seconds, but are counted synchronously with time of day seconds. This, and the way in which event occurrences are correlated to error-seconds in err-sec printouts, lead to the following conclusions:

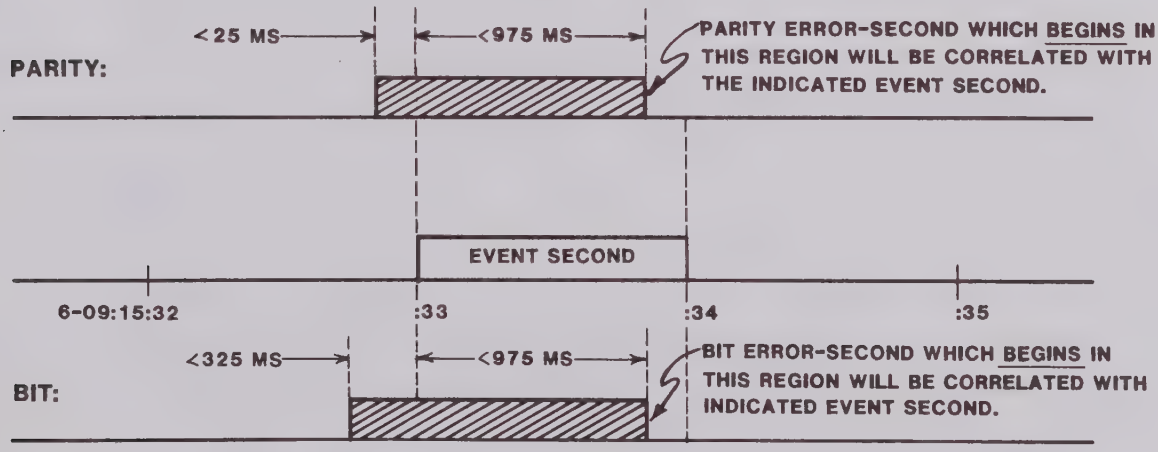
1) The total number of event-seconds may exceed the number of events correlated to error-seconds. Event and error-second totals alone are not sufficient to determine cause and effect relationships between events and errors. However, they are still useful in assessing overall system performance.

2) The way in which event occurrences are correlated to error-seconds provides a high probability of an event which caused an error-second to be recorded in the error-second printout. As a result, error-second printouts are extremely useful in determing cause and effect relationships between events and errors.

Error-seconds are correlated to event-seconds as described here and shown in the following diagram. Status event-seconds are synchronized to time-of-day seconds. For a parity error-second to be correlated and printed with an event-second, the synchronous error-second must begin not more than 25ms before the start of that event-second and not more than 975ms after the start of that event-second. An event which causes a parity error-second has a 97.5% probability ($\frac{975ms}{1000ms}$) of being recorded with that error-second. For a bit error-second to be correlated and printed with an event-second, the synchronous error-second must begin not more than 325ms before the start of that event-second and not more than 975ms after the start of that event-second. An event which causes a bit error-second has a 75% probability ($\frac{975ms}{975 + 325ms}$) of being recorded with that error-second.



Because status event-seconds are not synchronized to error-seconds, but are counted synchronously with time-of-day seconds, the number of status seconds in a summary printout may exceed the number of status events shown in error-second printouts. For example, consider the situation shown in the following diagram:



Since the burst of errors lasted less than one second, only one error-second will be counted and a single error-second printed. The time of the error-second will be reported as 6-09:15:33 and the frame loss event will be indicated. Even though the frame loss duration is less than one second, two frame loss seconds will be counted in the totals, and the summary printout will not appear to correlate with the error-second printouts.

4.5.2.3 **ERROR-SECOND SQUELCH**

An automatic squelch feature may be selected to suppress error-second printouts when system performance has degraded to the point where printing error-second data is a waste of paper. Errors and events that occur while printouts are squelched are still accumulated. Displayed or printed rates and totals contain all errors accumulated while printouts were suppressed. When selected:

Parity error-second printouts will be squelched when there are five consecutive seconds during which there was a frame loss. The printer will be re-enabled when there are five consecutive seconds during which there was no frame loss.

Bit error-second printouts will be squelched when there are five consecutive seconds during which there was a data sync loss. The printer will be re-enabled when there are five consecutive seconds during which there was no data sync loss.

The user is informed when printout is squelched or re-enabled as shown below:

Parity error-second printout squelched after 5 consecutive seconds of frame loss.

Error-second printout re-enabled after 5 consecutive seconds without frame loss.

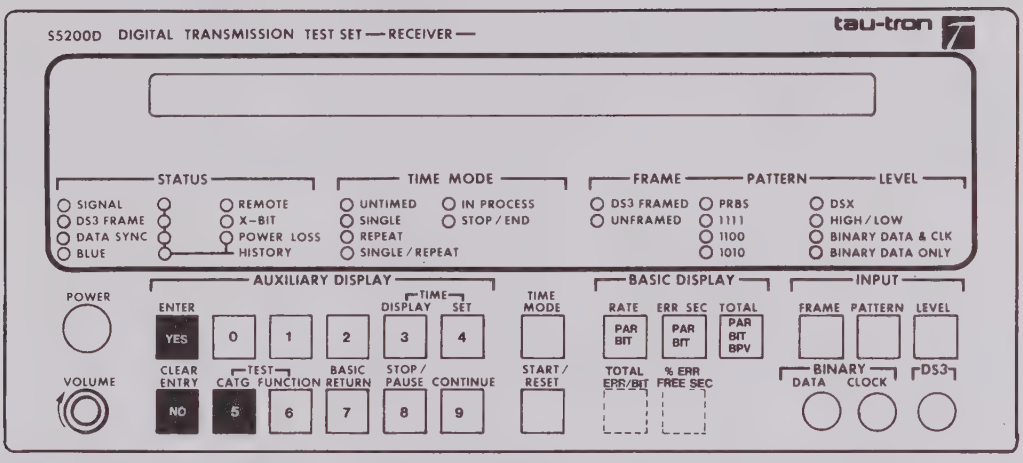
```
1-21:39:05 Bit=20257993,FrmSync    X
1-21:39:06 Bit=20254712,FrmSync    X
1-21:39:07 Bit=20257254,FrmSync    X
1-21:39:08 Bit=20258470,FrmSync    X
1-21:39:08    ERR-SEC PRINTOUT SQUELCHED
1-21:39:14    ERR-SEC PRINTOUT RE-ENABLED
```

4.5.2.4 **LOST DATA**

When the output data from the S5200D receiver occurs faster than the printer can print it, the data is stored in a 1024-byte queue. If this storage is exceeded, the receiver will keep track of the number of buffers (40-character lines) lost. When the printer is again ready for data, the number of lost buffers will be reported in hexadecimal notation.

4.5.2.5 **SELECTING PRINT FUNCTIONS**

The TEST CATEGORY, YES, and NO buttons are used to select printer functions as detailed below.



A summary printout is available at any time on demand by selecting an immediate summary as follows:

1. Push the TEST CATG until the display reads:

   DO YOU WANT PRINT FUNCTIONS? YES or NO

2. Push the YES button. The display will read:

   DO YOU WANT IMMEDIATE SUMMARY? YES or NO

3. Push the YES button. The display will read:

   DO YOU WANT IMMED PAR SUMMARY? YES or NO

4. If an immediate parity summary is desired, push the YES button. The display will return to the basic display and an immediate parity summary printout will occur.

5. If an immediate bit summary is desired, push the NO button. Display will read:

   DO YOU WANT IMMED BIT SUMMARY? YES or NO

   Push the YES button. The display will return to the basic display and an immediate bit summary will be printed.

Bit or parity summaries may be selected to print automatically at the end of timed intervals as follows:

1. Push the TEST CATG button until the display reads:

   DO YOU WANT PRINT FUNCTIONS? YES or NO

2. Push the YES button. The display will read:

   DO YOU WANT IMMEDIATE SUMMARY? YES or NO

3. Push the NO button. The display will read:

   DO YOU WANT PRINTER ENABLED? YES or NO

4. Push the YES button. The display will read:

   DO YOU WANT PARITY PRINTOUTS? YES or NO

5. If parity summaries are desired, push the YES button. The display will read:

   DO YOU WANT ERR-SEC PRINTOUT? YES or NO

   Push the NO button. The unit is now set to print a parity summary at the end of each timed interval.

6. If bit summaries are desired, push the NO button. The display will read:

   DO YOU WANT BIT PRINTOUTS? YES or NO

   Push the YES button. The display will read:

   DO YOU WANT ERR-SEC PRINTOUT? YES or NO

   Push the NO button. The unit is now set to print a bit summary at the end of each timed interval.

In addition to a summary printout at the end of each timed test, a printout is available at the end of each error-second. In order to prevent excessive printouts in the event of high error-rates, an error-second squelch can be selected.

1. Push the TEST CATG button until the display reads:

   DO YOU WANT PRINT FUNCTIONS? YES or NO

2. Push the YES button. The display will read:

DO YOU WANT IMMEDIATE SUMMARY? YES or NO

3. Push the NO button. The display will read:

   DO YOU WANT PRINTER ENABLED? YES or NO

4. Push the YES button. The display will read:

   DO YOU WANT PARITY PRINTOUTS? YES or NO

5. If parity printouts are desired, push the YES button. The display will read:

   DO YOU WANT ERR-SEC SQUELCH? YES or NO

6. If squelch is desired, push the YES button. If not, push the NO button. The unit will then be set to print a parity summary at the end of each test and parity error-second printouts at the end of each error-second.

7. If bit printouts are desired, push the NO button. The display will read:

   DO YOU WANT BIT PRINTOUTS? YES or NO

   Push the YES button. The display will read:

   DO YOU WANT ERR-SEC PRINTOUTS? YES or NO

   Push the YES button. The display will read:

   DO YOU WANT ERR-SEC SQUELCH? YES or NO

8. If squelch is desired, push the YES button. If not, push the NO button. The unit will then be set to print a bit summary at the end of each test and bit error-second printouts at the end of each error-second.

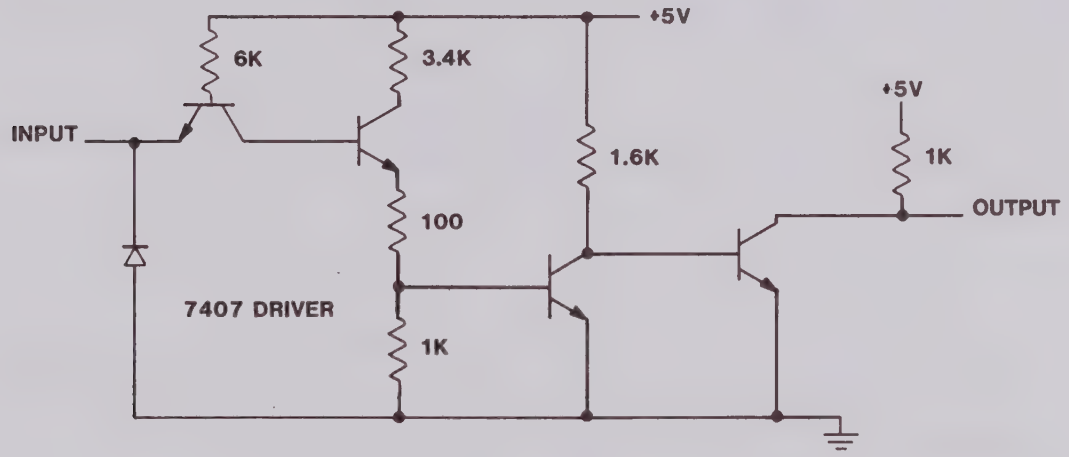
Section 5, Rear-Panel Interface

5.1 MONITOR CONNECTOR

A 24-pin D-type monitor connector on the rear-panel has inputs and outputs used for external monitoring. A mating connector (Tau-Tron part number 9300-0142) is supplied.

5.1.1 STATUS OUTPUTS

There are 6 status outputs which are TTL compatible with a source impedance of 1000 ohms to +5V. The output driver is a TTL driver 7407. The circuit description is shown below.



PIN	FUNCTION	
2	X-Bit	Occurs once per DS3 Master Frame and is active low.
3	Sync Loss	2^{15}-1 sequence generator in sync signal and is active low (out of sync).
4	Signal Loss	Indicates loss of input signal and is active low (no input).
14	Frame Loss	The DS3 Master Frame signal and is active low (loss of frame).
15	Blue Signal	A 1010 signal with DS3 frame information and is active low (blue signal detect).
13	PR Sync	A 15us pulse that occurs once per 2^{15}-1 sequence generator.

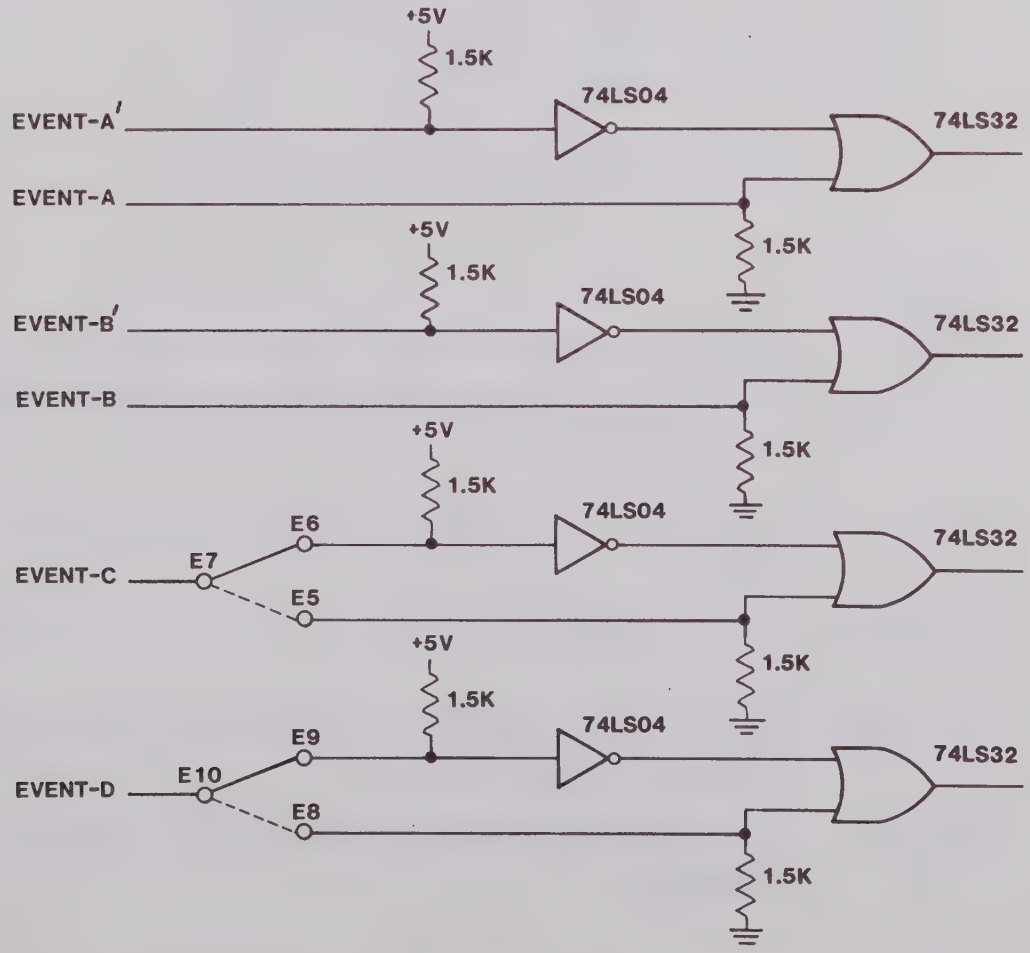
OTHER OUTPUTS

PIN	FUNCTION
8	AGC (automatic gain control) 3.6kohm source impedance. A DC voltage that indicates the level of the B3ZS DS3 input signal.
9	VCO (voltage control oscillator) 3.6kohm source impedance. A DC voltage that indicates that the VCO is locked into the incoming data rate at the B3ZS, DS3 input.

5.1.2 EXTERNAL EVENT INPUTS

Four TTL compatible inputs with a termination impedance of 1.5kohms. These inputs can be used for external alarms such as multiplexer, open door, AC generator alarm, etc.

The schematic of the event inputs is shown below. This circuitry is located on the Status and Control plug-in printed circuit board.



PIN	FUNCTION	
16	Event-A	Active High
5	Event-A'	Same input as Event-A only Active Low
17	Event-B	Active High
6	Event-B'	Same input as Event-B only Active Low
18	Event-C	Active Low
7	Event-D	Active Low

NOTE: Event-C and Event-D are set at the factory to be active low and may be set for active high by jumping E7 to E5 (Event-C) and by jumping E8 to E10 (Event-D) on the Status and Control plug-in printed circuit board.

PIN	FUNCTION
1	Circuit Ground
11	Circuit Ground
12	Circuit Ground
23	Circuit Ground
24	Circuit Ground

5.2 BNC SIGNAL OUTPUTS

There are five BNC output connectors located on the rear-panel. The following is a list of the signals and their output characteristics.

BPV

Level: ±0.5V into 75 ohms.
Pulse width: Positive true 11 ± 3ns.

Normal bipolar data have consecutive 1's that alternate in polarity. When two consecutive 1's have the same polarity, and do not conform to the B3ZS coding, the second is considered a bipolar pulse violation.

CLOCK

Level: ±0.5V squarewave into 75 ohms.
Frequency: 44.736MHz normal (follows input rate).

M SYNC

Level: TTL compatible, capable of driving 75 ohms.

Pulse width: 15.2us ±200ns, occurs once per DS3 Master Frame.

PARITY ERROR

Level: TTL compatible, capable of driving 75 ohms.

Pulse width: 300 ±50ns, one pulse per detected parity error.

BIT ERROR

Level: ±0.5V into 75 ohms.

Pulse width: positive true 11±3ns, one pulse per detected bit error.

5.3 RS-232C INTERFACE

When option 03, RS-232C Interface, is installed, the S5200D is provided with a standard two-way serial interface. The interface may be used to output measurements to a Tau-tron 5901 Printer or to any other device with an RS-232C Interface. It may also be used to remotely control and access data from the S5200D using a terminal or computer. This section describes in detail the RS-232C Interface, serial data format, and how to connect the S5200D receiver to RS-232C devices.

Section 4.5.2, Printer Outputs, describes how to select and output measurements to the RS-232C Interface.

5.3.1 INTERFACE CONNECTIONS

A 25-pin D-connector labeled RS-232 is provided on the rear panel of the S5200D receiver for use with external equipment. The connector is installed on all units but is functional only on units equipped with OP-03, RS-232C Interface. The signals that are used are wired in accordance with EIA RS-232C standards for Data Terminal Equipment (DTE).

PIN	NAME	FUNCTION
1	GND	Protective ground.
2	TxD	Transmitted data output: Bit-serial data stream. Format is selected by rear-panel DIP switch.
3	RxD	Received data input: Bit-serial data stream. Commands to the S5200D are received on this input. Format selected by rear-panel DIP switch.
4	RTS	Request to send output: Hi-level when S5200D receiver has data for output.
5	CTS	Clear to send input: Hi-level indicates external device, such as printer, is ready to accept data. This line must be high to enable the S5200D receiver to output data. A low-level indicates the output device is busy or its buffer is full.
6	DSR	Data set ready input: Unused.
7	GND	Signal ground.
8	DCD	Received line signal detect input: (carrier detect) High-level (>3V dc) indicates external device, such as CRT terminal, wants to send commands to S5200D. This line must be high to enable the S5200D to accept input commands on line 3. When this signal is absent or low, inputs on line 3 are ignored.

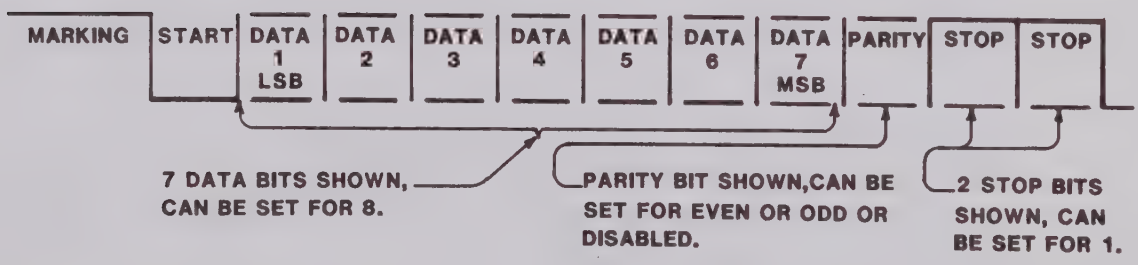
PIN	NAME	FUNCTION
20	DTR	Data terminal ready output: Set to on (greater than +3V) by S5200D receiver.
All Others		No connection.

The S5200D may be configured for full-duplex or half-duplex operation. In full duplex mode, all characters received without error on the received data line (pin 3) are echoed back to the source on the transmit data line. No echoing is done in half-duplex mode. During full duplex operation, commands and data may be received and transmitted simultaneously. In half-duplex interface, only one function, transmit or receive, may take place at a time. The request to send (RTS), clear to send (CTS), and data carrier detect (DCD) signals control which function is active on a half-duplex channel. The RS-232C standard defines when transitions on the RTS, CTS, DSR, DTR, and DCD lines may take place.

5.3.2 SERIAL DATA FORMAT

Data is output from the S5200D in an asynchronous bit-serial fashion at one of eight selectable baud rates. The format of the bit-serial data stream is as shown:

MARKING LINE < -3V
SPACING LINE > +3V



5.3.3 BAUD RATE AND OPTION SELECTION

The data baud rate, number of bits per character, parity selection, and number of stop bits are selected by the rear-panel DIP switch. Switch assignments are as follows:

Switch	Function (1=on=switch up)	Switch 1	2	3	Baud Rate (bits/sec)
1 (left)	Baud rate.....	0	0	0	110
2.....	Baud rate.....	1	0	0	150
3.....	Baud rate.....	0	1	0	300
		1	1	0	600
		0	0	1	1200 (standard)
		1	0	1	2400
		0	1	1	4800
		1	1	1	9600

4.....	Bits/character.....0=7, 1=8	
5.....	Parity enable.....0=disable, 1=enable	
6.....	Parity odd-even.....0=odd, 1=even	
7.....	Stop bits.....0=1 stop, 1=2 stops	
8 (right)	Duplex half/full....0=half, 1=full	

NOTE THE DIP SWITCH IS READ ON POWER-UP ONLY. To change the S5200D receiver's baud rate or other characteristics, the receiver must be turned off, then back on.

When using the RS-232C compatible Tau-tron 5901 Printer, the DIP switch should be set as follows:

Switch:	1	2	3	4	5	6	7	8
Setting:	OFF	OFF	ON	OFF	OFF	OFF	ON	OFF

5.3.4. S5200D REMOTE CONTROL COMMANDS

All S5200D Receiver capabilities controllable from the front panel may be controlled remotely. Programming the S5200D via RS-232 is as simple as programming it via front-panel entry. Twenty-seven commands correspond to front-panel pushbuttons. These commands must be issued in the same sequence as front-panel selects to select Receiver functions. Five additional commands are provided to acquire measurements or status from the Receiver, enable/disable front-panel pushbutton recognition, and reinitialize the S5200D to its power-up state.

5.3.4.1 REMOTE COMMAND SEQUENCES

All device-dependent command sequences must be issued in the following format:

CMD 1 (delimiter CMD2) (delimiter CMD3) ... CR, LF

CMD 1, 2, 3, etc., are any of the one or two character mnemonics shown in the table (page 5-30) and described in Section 5.4.5.2. Command mnemonics are read as 7- or 8-bit ASCII characters off the receive data line (pin 3). Command sequences may contain one or more commands and must be terminated by a carriage return and line feed. A command sequence must not exceed 128 characters in length. Multiple commands in a command sequence must be separated by any of the following valid delimiters:

Delimiter	ASCII Code (hex)
SP (blank).....	20
NULL (null byte)....	00
, (comma).....	2C
; (semicolon).....	3B
HT (tab).....	Ø9

The S5200D will backspace and delete received characters when the ASCII backspace (HEX 08) or rubout (HEX 7F) character is received. In full-duplex mode, the received backspace or rubout character will be echoed to the remote controller. In addition, the receiver will echo a carriage return and line feed when a carriage return is received. Commands are not accepted and responded to until the carriage return and line feed are received.

5.3.4.2 RESPONSE TO COMMANDS AND COMMAND ERRORS

When the carriage return and line feed terminating a command sequence are received, the S5200D decodes and responds to the command sequence. Multiple commands in a sequence are responded to one at a time. If any of the commands are improper, the S5200D outputs "WHAT?" to the RS-232C interface, but responds to all valid commands in the sequence. If all commands in the sequence are valid, the S5200D outputs "OK" to the RS-232C interface. "WHAT?" or "OK" is output in both full and half-duplex modes. If the S5200D is in the middle of sending printer outputs or requested data, the command acknowledgements may be interspersed with the data.

Two types of errors may occur. If parity detection is enabled, each received character is checked for proper parity. Characters with improper parity are ignored. In full duplex operation, only characters with the correct parity are echoed to the remote controller, indicating their acceptance.

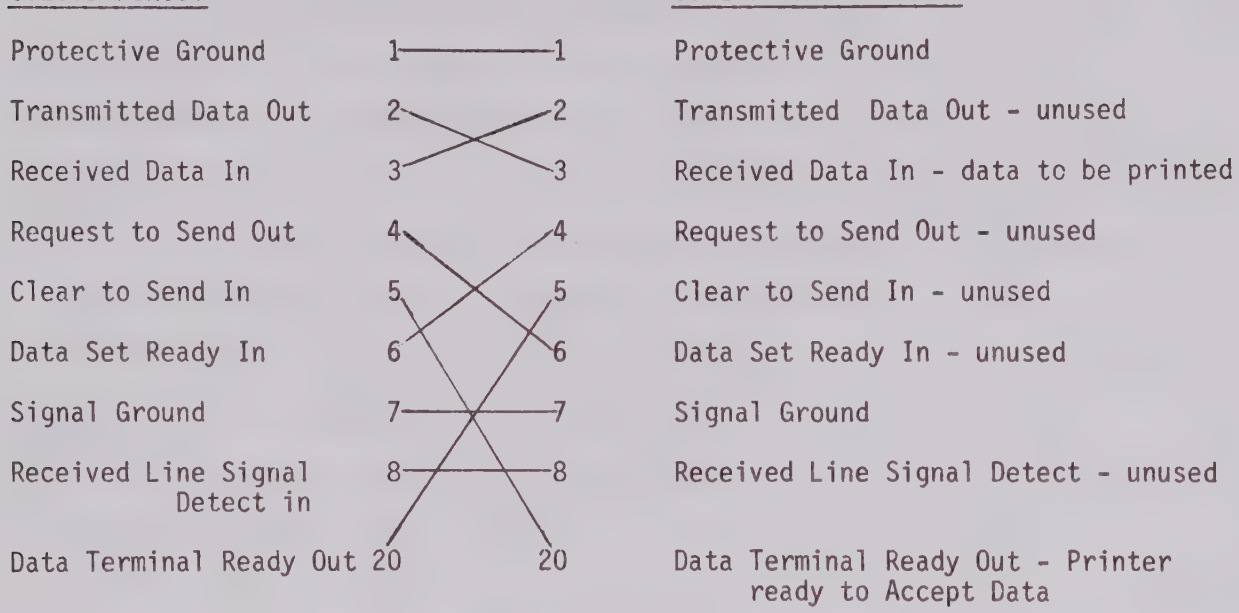
Invalid commands are ignored by the S5200D Receiver. If a multiple command sequence contains an invalid command, valid commands in the sequence will still be interpreted and responded to. Since many S5200D remote commands depend on previous commands, valid commands, in sequences containing an invalid command may be misinterpreted. For example, if the Receiver is in an untimed mode, the sequence MD, MD, MD, YS, 1, Ø, YS (identical to pushing front-panel pushbuttons TIME MODE, TIME MODE, TIME MODE, YES, 1, Ø, ENTER) will select a 10 second repeat test. If a mistake was made and MD, MD, ND, YS, 1, Ø, YS was entered, the invalid ND command would be ignored, the S5200D would send back "WHAT?", and the command sequence would be responded to as if the pushbutton sequence TIME MODE, TIME MODE, YES, 1, 0, ENTER had been entered. The result would be a 10 second single test instead of a 10 second repeat test. Valid command mnemonics may be treated as invalid commands if they have no meaning in the Receiver's current mode. For example, when selecting Receiver time mode, only the mode (MD), yes (YS), no (NO), basic return (RT), frame (FR), pattern (PA), and level (LV) pushbuttons have meaning. Any other command, such as time display (TD), will be ignored and the S5200D will respond with "WHAT?".

5.3.5 INTERFACE TO THE TAU-TRON 5901 PRINTER

Tau-tron's model 5901 printer has been specifically selected for S5200D applications. Interfacing requires a null modem and 9-wire RS-232C cable.

RS-232C specifies equipment as either "data-terminal" or "data-communications" equipment. When similarly configured equipment try to talk to each other, a null modem is required. Since both the S5200D and the 5901 printer are configured as "data-terminal" equipment, a null modem allows each device to see the other as

"data-communications" equipment. The diagram below lists RS-232C pin connections on both sides and shows the null modem wiring:



All other wires in the 25-wire interface are not connected. A null modem with this configuration is shipped with the 5901 Printer.

The RS-232C cable shipped with the 5901 printer is a 9-wire, 10-foot cable. The pinout is straight-through (no cross-connection) on pins 1-8 and 20. All other pins are not connected.

The 5901 printer is shipped from Tau-tron in the following configuration:

1200 baud
7-bit word length
1 stop bit
no parity

The S5200D should be configured by the rear-panel DIP switches to talk to the 5901 printer:

1200 baud
7-bit word length
2 stop bits
no parity

NOTE Configuring the S5200D to transmit 2 stop bits ensures the 5901 printer will detect the next start bit and resync on it.

5.3.6 INTERFACE TO OTHER RS-232C DEVICES

Interfacing the S5200D to other RS-232C devices is very simple if you know the pinout and configuration of the other device. All "data terminal equipment" transmits on line 2 and receives on line 3. All "data communications equipment" transmits on line 3 and receives on line 2. Different printers typically provide their clear-to-send (printer ready for data) handshake on different lines. A null modem may be necessary to cross-connect the printer handshake to the S5200D's clear-to-send input. The S5200D must see clear-to-send active before it will transmit data. It will continue to transmit data at the specified baud rate until the clear-to-send line goes inactive or there is no more data to be output. The S5200D must be set up (by rear-panel DIP switches) to transmit at the same baud rate, parity selection, and data word length as the receiving device. Generally, the S5200D should be set up to transmit 2 stop bits. This gives the receiving device a better chance to resync on the next start bit.

The S5200D must see Receive Line Signal Detect (pin 8) active before it will accept data on its Receive Data Line (pin 3). A modem provides this signal on pin 8 whenever it has detected a carrier (i.e., phone link completed to another modem). If the S5200D is connected directly to a terminal, it may be necessary to cross-connect the terminal's power on signal (often pin 20, Data Terminal Ready) to the S5200D's pin 8 input.

5.3.7 INTERFACING AN RS-232C TERMINAL TO THE S5200D RX

The RS-232C Interface specification allows many different configurations. Data rate, format, and content are not strictly specified. Hence, getting a device's RS-232C Interface to talk to another often requires some initial configuration. A basic knowledge of the RS-232C Interface will greatly simplify this task (see Sect. 5.3).

Once familiar with RS-232C, the following procedure will ease interface setup.

1) Determine terminal's (or printer, modem, computer, or other RS-232C device) RS-232C pinout. Consult user manual for terminal to determine its pinout. Make proper connection as described in Sections 5.3.1, 5.3.6, and 5.3.8. A null modem may be required to cross-connect transmit, receive, and handshake signals.

2) Determine terminal's serial data format. Select S5200D format to match, as described in Sections 5.3.2 and 5.3.3.

3) Turn on terminal and S5200D. Manually select immediate summary print and verify output at terminal. If no output or garbled output, use Section 5.3.8 as a guide in determining and correcting the problem.

4) When the previous step is completed successfully, press the (RETURN) key on the terminal. Verify "OK" or "WHAT?" response output to terminal. If no response, consult Section 5.3.8.

5) After successfully completing the last step, type in a sequence of commands (See Section 5.3.4) corresponding to a valid sequence of key hits. Verify the S5200D responds to the commands and sends back "OK" response.

5.3.8 RS-232C INTERFACE TROUBLESHOOTING

The EIA RS-232C Interface specification allows many different configurations. Data rates, format, and content are not strictly specified. Hence, getting one device's RS-232C Interface to talk to another one often requires some initial configuration. Rear-panel DIP switches on the S5200D receiver permit the user to configure the instrument's RS-232C interface to match the characteristics of many RS-232C peripherals. This section describes commonly encountered problems and their solutions when trying to make the S5200D communicate via RS-232C.

The RS-232C specification defines separate transmit and receive data lines. The S5200D outputs bit-serial information over the transmit data line (pin 2 of the connector). Many printers, including Tau-tron's 5901 Printer, expect data on the receive data line (pin 3). If this is the case, the S5200D's transmit data line must be connected to the printer's receive data line. The 5901 printer is supplied with a null modem to accomplish this cross-connection.

In order for the S5200D to transmit data, its clear-to-send input (pin 5) must be active (>3VDC). The 5901 printer supplies this signal on its data-terminal-ready line (pin 20). Again, the null modem makes the required cross-connection. If the printer is off-line or busy (not ready to accept data), it will drive this line inactive, signalling the S5200D to stop sending data to the printer.

The S5200D expects to receive remote commands in bit-serial form on its receive data line (pin 3). In order for the S5200D to accept commands on its receive data line, its received line signal detect input (pin 8, sometimes called data carrier detect) must be active (>3VDC).

The serial data stream consists of a start bit, 7 or 8 data bits, possibly a parity bit, and 1 or 2 stop bits. The baud rate, number of data bits per character, and parity bit selection must match the format expected by the printer. The S5200D should generally transmit two stop bits, while the printer should look for one. The configuration of these interface characteristics is controlled by DIP switches on the rear-panel of the S5200D. Section 5.3.3 describes DIP switch settings and meanings.

NOTE DIP SWITCHES ARE READ ONLY ON POWER-UP. If a configuration change must be made, the S5200D must be turned off, the appropriate DIP switches toggled, and the S5200D turned back on.

When the rate at which printer output is generated exceeds the printer capability to print it, some data must be lost. The RS-232C clear-to-send handshake line must be enabled for the S5200D-RX to output the data to the printer. When the printer is busy, off-line, or out of paper, it may disable this line, signalling the S5200D to discontinue output. As more error-seconds occur, print messages will continue to be generated in the S5200D. 1024 bytes of queue storage are provided for backing up data. When this queue space is filled, the S5200D will keep track of the number of "buffers" lost. Each print buffer corresponds to a 40-character print line. When the printer is again ready for data, the number of lost buffers will be reported.

NOTE The lost buffer count is reported in hexadecimal.

The source of nearly all interface problems is improper connections and/or mismatches in the transmitted and expected data rate or format. The following table lists several commonly encountered symptoms, their likely causes, and solutions.

PROBLEM SYMPTOM	POSSIBLE CAUSE	SOLUTION
FRONT-PANEL DISPLAY SHOWS "PRINTER NOT INSTALLED" or "GPIB or RS-232C REQUIRED".	NEITHER RS-232C NOR GPIB OPTION HAS BEEN PURCHASED.	Consult Tau-tron sales representative if you wish to purchase one or both of these options.
	INTERNAL DIP SWITCHES IMPROPERLY SET.	Consult Tau-tron customer service personnel.
PRINTER FAILS TO PRINT ANY DATA.	PRINTER OFF.	Plug in printer and turn it on.
	PRINTER OFF-LINE.	Some printers, including the Tau-tron 5901, have an on-line/off-line switch. Make sure the printer is on-line.

PROBLEM SYMPTOM	POSSIBLE CAUSE	SOLUTION
	CABLE NOT CONNECTED.	Connect RS-232C cable.
	IMPROPER CONNECTION.	Make sure pin 2 from S5200D is wired to printer's input data line. Make sure pin 5 input at S5200D is receiving clear-to-send indication from printer.
PRINTOUT IS GARBLED.	DATA RATE OR FORMAT MISMATCH.	Turn off S5200D and toggle rear-panel DIP switches to select proper baud rate, parity, and number of data bits/char to match printer setup. Turn S5200D back on.
CHARACTER OCCASIONALLY LOST IN PRINTOUT.	SYNC LOSS.	Turn off S5200D and set rear-panel DIP switch for 2 stop bits. Set printer for 1 stop bit. Turn S5200D back on.
MULTIPLE CHARACTERS OCCASIONALLY LOST IN PRINTOUT.	DATA OVERRUN.	Printer is not toggling S5200D's clear-to-send line when it is busy and unable to accept data. S5200D keeps transmitting and data is lost. Provide signal from printer to pin 5 of S5200D interface. Signal must be active (>3VDC) when printer is ready to accept data and inactive (<-3VDC) when printer is busy.
S5200D OUTPUTS PRINT FUNCTIONS TO TERMINAL BUT DOES NOT ACCEPT REMOTE COMMANDS.	IMPROPER CONNECTION.	Make sure S5200D's receive data line (Pin 3) is connected to remote controller's transmit data line. Make sure S5200D's Receive Line Signal Detect (Pin 8) is active (connected to modem Carrier Detect or remote controller power-on or ready line).
	DATA FORMAT MISMATCH.	Turn off S5200D and toggle rear-panel DIP switches to select parity and number of data bits per character to match remote controller setup. Turn S5200D back on.
	INTERNAL DIP SWITCHES IMPROPERLY SET.	Consult Tau-tron Customer Service.

PROBLEM SYMPTOM	POSSIBLE CAUSE	SOLUTION
CHARACTERS TYPED AT REMOTE CONTROL TERMINAL APPEAR TWICE ON SCREEN.	TERMINAL IN HALF DUPLEX; S5200D IN FULL DUPLEX.	S5200D echoes back received characters when it is in FULL duplex mode. Terminal displays typed characters also if it is in HALF duplex mode. Turn off S5200D. Toggle DIP switch 8 to OFF. Turn S5200D back on.
CHARACTERS TYPED AT REMOTE CONTROL TERMINAL DO NOT APPEAR ON SCREEN, BUT ARE ACCEPTED BY S5200D.	TERMINAL IN FULL DUPLEX; S5200D IN HALF DUPLEX.	Turn off S5200D. Set DIP switch 8 to ON. Turn on S5200D. S5200D will echo back all received characters to verfy their reception.

5.4 IEEE-488 INTERFACE (GPIB)

When option 02, IEEE-488 Interface (GPIB), is installed, the S5200D may communicate with other GPIB compatible devices as a talker/listener or talker only. This section provides an introduction to GPIB and details of S5200D receiver GPIB capabilities.

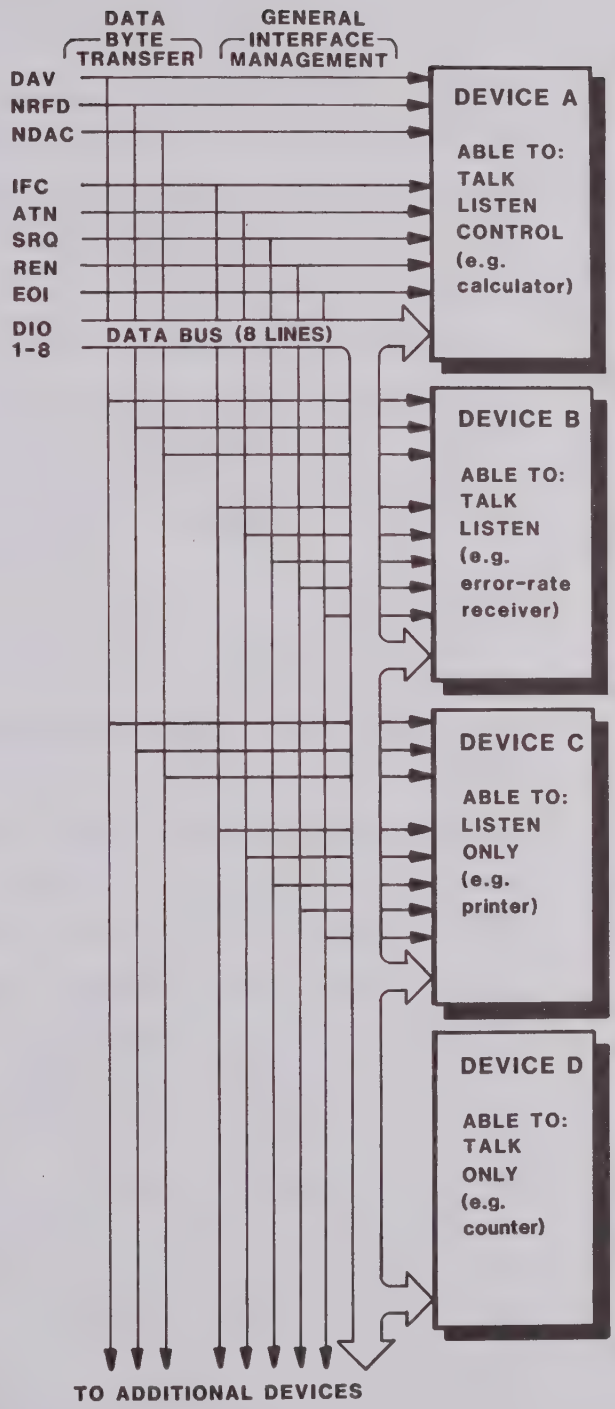
5.4.1 INTRODUCTION

Description of IEEE-488

The GPIB (General Purpose Interface Bus) transfers data and commands between the units of an instrumentation system on 16 lines. The interface functions for each unit are performed within the unit so only passive cabling is necessary to connect the system. The cables connect all instruments, controllers, and other units of the system in parallel across the signal lines.

Eight of the lines (DIO1 thru DIO8) are reserved for the transfer of data and other messages in a byte-serial, bit-parallel manner. Data and message transfer is asynchronous and coordinated by the three handshake lines: DAV (data valid), NRFD (not ready for data), and NDAC (not data accepted). The other five lines are for control of bus activity.

Devices connected to the bus may be talkers, listeners, or controllers. The controller dictates the roll of each of the other units by setting



the ATN (attention) line true and sending talk or listen addresses on the data lines (DIO1 thru DIO8). Addresses are set into each device at the time of system configuration either by switches built into the unit or by jumpers on a printed-circuit board. While the ATN line is true, all units must listen to the data lines. When the ATN line is false, only devices that have been addressed will actively send or receive data. All others ignore the data lines.

Several listeners can be active simultaneously, but only one talker can be active at a time. Whenever a talk address is put on the data lines (while ATN is true), all other talkers should be automatically unaddressed.

Information is transmitted on the data lines under sequential control of the three handshake lines. No step in the sequence can be initiated until the previous step is completed. Information transfer can proceed as fast as units can respond, but no faster than allowed by the slowest device being addressed as active. This permits several devices to receive the same message byte concurrently.

The ATN line is one of five control lines. When ATN is true, addresses and universal commands are transmitted on only seven of the data lines using ASCII code. When ATN is false, any code of eight bits or less understood by both the talker and listener(s) can be used.

The other control lines are IFC, REN, SRQ, and EOI. IFC (interface clear) places the interface system in a quiescent state. REN (remote enable) is used with other coded messages to select either local or remote control of each unit.

Any active unit can set the SRQ (service request) line to true. This indicates to the controller that some unit on the bus wants attention; for example, a counter on a bus may want attention because it has just completed a time-interval measurement and wants to transmit the reading to a printer.

EOI (end or identify) is used by a unit to indicate the end of a multiple-byte transfer sequence. When a controller sets both ATN and EOI lines to true, each unit capable of a parallel poll indicates its current status on the data line (DIO1 thru DIO8) assigned to it.

It is not necessary that every unit be capable of responding to all of the lines. Each unit can be designed to respond only to those lines that are pertinent to its functions on the bus.

S5200D Receiver GPIB capabilities

The S5200D receiver may be interfaced as a talker/listener or a talker only. No controller functions are implemented. As described in the IEEE-488-1978 (GPIB) standard, the following GPIB capabilities are implemented:

SH1 Complete source handshake

AH1 Complete accepter handshake.

T5 Basic talker, serial poll, talk only, uaddress if addressed to listen.

TE0 No extended talker (secondary talk address) capability.

L4 Basic listener, no listen only, unaddress if addressed to talk.

LE0 No extended listener (secondary listen address) capability.

SR1 Complete service request capability.

RL2 No local lockout on remote/local capability.

PP0 No parallel poll capability.

DC1 Complete device clear capability.

DT1 Complete device trigger capability.

C0 No control capability.

E2 Tri-state drivers are used on DIO lines to achieve maximum data transfer rates.

5.4.2 GPIB INTERFACE CONNECTIONS

A 24-pin GPIB connector is provided on the rear panel of the S5200D receiver. Connector dimensions and pinouts correspond to IEEE specifications. The connector is mounted on all units, but is operational only on units equipped with OP-02, IEEE-488 Interface. Tri-state drivers are used on the DIO lines in the talk mode to achieve higher data-transfer rates.

5.4.3 GPIB ADDRESS AND OPTION SELECTION

When Option 02, IEEE-488 Interface (GPIB) is installed, the 8-section DIP switch on the rear panel is used for GPIB talk/listen address and option selection as follows:

Switch	Function (1=on=switch up)	
1(left)	SRQ Enable.....	With this switch on, the S5200D receiver is allowed to generate service requests (assert the GPIB SRQ line). In systems with many GPIB units, this may not be desirable. Service requests can be inhibited by setting this switch down to its off position. The S5200D receiver maintains status and will respond to serial polls regardless of the SRQ Enable setting.
2.....	Talk Only.....	With this switch on, the S5200D receiver is allowed to be used in a system with a listen-only printer and no controller. In this mode, print functions can be selected from the front panel and the printer output sent to a GPIB printer. The S5200D receiver will ignore all GPIB commands when in a talk-only mode (switch 2 up).
3.....	Listen Only.....	This setting is ignored by the S5200D receiver since it does not have a listen-only mode of operation.

4..... Address A5..... A1 thru A5 plus two additional bits, independent of
5..... Address A4 the switch settings, form a 7-bit talk and listen
6..... Address A3 address. A1 is the least-significant bit, A2 is the
7..... Address A2 next most significant, etc. The two additional bits
8..... Address A1 are the most-significant bits and are fixed as 1-0 for a talk address, and as 0-1 for a listen address. Once the 5 address bits A1 thru A5 are selected, both talk and listen addresses are specified for the receiver.

NOTE THE DIP SWITCH IS READ ON POWER-UP ONLY. To change the S5200D receiver's GPIB address or other characteristics, the receiver must be turned off then back on.

5.4.4 RESPONSE TO GPIB COMMANDS

The following GPIB commands and events are responded to by the S5200D receiver:

S5200D-RX addressed to listen
Universal unlisten commanded
S5200D-RX addressed to talk
Universal untalk commanded
Data byte received
Remote/local commanded
Device clear commanded
Device trigger commanded
Serial poll enable/disable commanded

Several GPIB copabilities are not supported by the S5200D receiver. The following commands are ignored by the receiver:

Local Lockout
Identify (parallel poll trigger)
Secondary addresses
Parallel poll configure/unconfigure
Parallel poll enable/disable
Take control

The following paragraphs detail the GPIB commands and events to which the S5200D receiver will respond.

5.4.4.1 S5200D TRANSMITTER ADDRESSED TO LISTEN

CODE	DATA 8 7 6 5 4 3 2 1								BUS					DIO			INTERFACE MANAGEMENT ATN	EOI	SRQ	IFC	REN
MLA	Y	O	1	L 5	L 4	L 3	L 2	L 1									1	X	X	X	X

L1-L5 specify the device dependent bits of the device's listen address as set by the rear-panel DIP switch.

When MLA my listen address is present on the GPIB bus, the S5200D receiver will be addressed to listen. If previously addressed to talk, the receiver will automatically untalk. The receiver cannot be configured to talk and listen at the same time in order to prevent its talk data from being interpreted as commands.

5.4.4.2 UNIVERSAL UNLISTEN COMMANDED

CODE	DATA BUS DIO 8 7 6 5 4 3 2 1	INTERFACE MANAGEMENT ATN EOI SRQ IFC REN
UNL	Y 0 1 1 1 1 1 1	1 X X X X

When UNL unlisten is present on the GPIB bus, the S5200D receiver will cease to listen and addressed commands (GET, GTL, and SDC) and data will be ignored. Universal commands (IFC, REN, DCL, SPE, SPD, MLA, and MTA) will continue to be recognized and responded to.

5.4.4.3 S5200D RECEIVER ADDRESSED TO TALK

CODE	DATA BUS DIO 8 7 6 5 4 3 2 1	INTERFACE MANAGEMENT ATN EOI SRQ IFC REN
MTA	Y 1 0 T5 T4 T3 T2 T1	1 X X X X

T1-T5 on the DIO lines specify the device dependent bits of the device's talk address as set by the rear-panel DIP switch.

When MTA my talk address is present on the GPIB bus, the S5200D receiver will be addressed to talk. If previously addressed to listen, the receiver will automatically unlisten to prevent output data from being interpreted as commands. Since a GPIB system can have only one talker, unique talk addresses must be selected for each device in the system. All other devices must untalk when the receiver is addressed to talk. If addressed to talk after SPE (serial poll enable) and before SPD (serial poll disable), the receiver will respond by putting its status byte on the DIO lines (described later under Service Request and Serial Poll). Otherwise, receiver output data (i.e., measurements) will be placed on the DIO lines. If the receiver has nothing to say, it will output one or two null bytes along with the EOI signal.

5.4.4.4 UNIVERSAL UNTALK COMMANDED

CODE	DATA BUS DIO 8 7 6 5 4 3 2 1	INTERFACE MANAGEMENT ATN EOI SRQ IFC REN
UNT	Y 1 0 1 1 1 1 1	1 X X X X
OTA	OTA = SGA ∧ $\overline{\text{MTA}}$	

The UNT code is provided for system use.

The presence of UNT untalk command or a talk address other than the S5200D receiver's (OTA other talk address) causes the receiver to become unaddressed to talk. If service requests are not inhibited and the receiver still has data it wishes to output, a service request indicating request-to-talk will be generated.

5.4.4.5 DATA BYTE RECEIVED

CODE	DATA BUS DIO 8 7 6 5 4 3 2 1	INTERFACE MANAGEMENT ATN EOI SRQ IFC REN
ATN	X X X X X X X X	1 X X X X
DAB	D D D D D D D D 8 7 6 5 4 3 2 1	0 X X X X

D1-D8 specify the device dependent data bits.
The source of the message on the ATN line is always the C function, whereas the messages on the DIO and EIO lines are enabled by the T function.

When the GPIB ATN attention line is inactive and the S5200D receiver is addressed to listen, bytes received on the eight DIO lines will be interpreted as device-dependent commands (see 5.4.5, Device-Dependent Commands).

5.4.4.6 INTERFACE CLEAR COMMANDED

CODE	DATA BUS DIO 8 7 6 5 4 3 2 1	INTERFACE MANAGEMENT ATN EOI SRQ IFC REN
IFC	X X X X X X X X	X X X 1 X

When the IFC interface clear line is asserted on the GPIB bus, the S5200D receiver reinitializes its interface functions as described by IEEE-488-1978 state diagrams. A pending service request will be cleared. The stauts byte in the receiver is not cleared, however. It may be polled to determine if bus errors, indicated in the status byte, may have caused bus problems prior to the interface clear command. If previously in remote mode, IFC will not return the receiver to local control.

5.4.4.7 REMOTE/LOCAL COMMANDED

CODE	DATA BUS DIO 8 7 6 5 4 3 2 1	INTERFACE MANAGEMENT ATN EOI SRQ IFC REN
GTL	Y 0 0 0 0 0 0 1	1 X X X X
LLO	Y 0 0 1 0 0 0 1	1 X X X X
REN	X X X X X X X X	X X X X 1

When the REN remote enable line is asserted on the bus and the S5200D receiver is addressed to listen, the receiver is put in remote mode. Since the receiver has no return-to-local front-panel control, local lockout capability is not provided. While in remote mode, all local control (front-panel pushbuttons) is disabled. The receiver may be remote-enabled only by first asserting the REN line then being addressed to listen. When in remote control, REN going inactive will return it to local control. If addressed to listen and in remote, the presence of the GTL go to local message returns the receiver to local control. LLO local lockout is ignored at all times.

5.4.4.8 DEVICE CLEAR COMMANDED

CODE	DATA BUS DIO 8 7 6 5 4 3 2 1	INTERFACE MANAGEMENT ATN EOI SRQ IFC REN
DCL	Y 0 0 1 0 1 0 0	1 X X X X
SDC	Y 0 0 0 0 1 0 0	1 X X X X

The S5200D receiver may be cleared by DCL universal device clear or SDC selective device clear. SDC is accepted by the S5200D only if it has been addressed to listen. DCL is responded to in any mode. In response to a device clear command, the receiver re-executes its power-up initialization sequence, including reinitializing its GPIB interface function. If previously addressed to talk or listen, the receiver will return to its unaddressed state.

NOTE At least two seconds should be allowed before issuing any further commands in order to give the receiver time to complete its power-up reinitialization sequence.

5.4.4.9 DEVICE TRIGGER COMMANDED

CODE	DATA BUS DIO 8 7 6 5 4 3 2 1	INTERFACE MANAGEMENT ATN EOI SRQ IFC REN
GET	Y 0 0 0 1 0 0 0	1 X X X X

When GET group trigger execute command is present on GPIB bus and the S5200D receiver has been addressed to listen, it will execute its start/reset function. This action is identical to pushing the front-panel START/RESET button on the receiver.

5.4.4.10 SERIAL POLL ENABLE/DISABLE COMMANDED

CODE	DATA BUS DIO 8 7 6 5 4 3 2 1	INTERFACE MANAGEMENT ATN EOI SRQ IFC REN
SPD	Y 0 0 1 1 0 0 1	1 X X X X
SPE	Y 0 0 1 1 0 0 0	1 X X X X

The SPE serial poll enable and SPD serial poll disable commands are recognized by the S5200D receiver when they are present on the bus. In response to a serial poll, the receiver will put its GPIB status byte on the DIO lines. The serial poll command sequence and status byte interpretation are described later under Service Request and Serial Poll.

5.4.4.11 UNSUPPORTED GPIB COMMANDS

CODE	DATA 8	7	6	5	BUS 4	3	DIO 2	1	INTERFACE MANAGEMENT ATN	EOI	SRQ	IFC	REN
IDY	X	X	X	X	X	X	X	X	1	1	X	X	X
LLO	Y	0	0	1	0	0	0	1	1	X	X	X	X
MSA	Y	1	1	S5	S4	S3	S2	S1	1	X	X	X	X
OSA	OSA = SCA ∧ $\overline{\text{MSA}}$												
PPC	Y	0	0	0	0	1	0	1	1	X	X	X	X
PPE	Y	1	1	0	S	P3	P2	P1	1	X	X	X	X
PPD	Y	1	1	1	D4	D3	D2	D1	1	X	X	X	X
PPU	Y	0	0	1	0	1	0	1	1	X	X	X	X
TCT	Y	0	0	0	1	0	0	1	1	X	X	X	X

S1-S5 specify the device dependent bits of the device's secondary address. S specifies the sense of the PPR, for S=0, response=0, for S=1, response=1. P1-P3 specify the PPR message to be sent when a parrallel poll is executed. D1-D4 specify don't - care bits that shall not be decoded by the receiving device . It is recommended that all zeros be sent.

No parallel poll functions (IDY identify, PPC parallel poll configure, PPE parallel poll enable, PPD parallel poll disable, and PPU parallel poll unconfigure), secondary address (MSA my secondary address and OSA other secondary address), LLO local lockout, or control functions (TCT take control) are supported by the S5200D receiver. The occurrence of these commands on the bus is ignored at all times. Undefined GPIB commands received with the ATN line asserted are also ignored.

5.4.5 DEVICE-DEPENDENT COMMANDS

All S5200D Receiver capabilities controllable from the front panel may be remotely controlled. A set of device-dependent commands issued on the GPIB bus selects S5200D commands. When the S5200D is addressed to listen, data accepted on the DIO lines are interpreted as receiver commands.

Programming the receiver in remote control is as simple as programming it by front-panel entry. Twenty-seven commands correspond to front-panel pushbutton selects. These commands must be issued in the same sequence as front-panel push-buttons to select the receiver functions. Two additional commands are provided to return 40-character receiver status or snapshot the 40-character display. The table summarizes device-dependent commands.

5.4.5.1 COMMAND SEQUENCE FORMATS

All device-dependent command sequences must be issued in the following format:

Command 1 (delimiter command 2) (delimiter, command 3) ....CR, LF

Where commands 1, 2, 3, etc., are any of the one or two-character mnemonics shown in the table on the following page. Command mnemonics are read as 7-bit ASCII codes off the DIO lines. Multiple commands in a command sequence must be delimited by any of the following valid delimiters. Every command sequence must be terminated by a carriage return and line feed.

Delimiter		ASCII Code (hex)
SP	(blank).....	20
NUll	(null byte)....	00
,	(comma).....	2C
;	(semicolon)....	3B
HT	(tab).....	09

Valid command mnemonics may be treated as invalid commands if they have no meaning in the receiver's current mode. For example, when selecting the receiver time mode, only the yes (YS), no (NO), mode (MD), basic return (RT), frame (FR), pattern (PA), and level (LV) commands have meaning.

Invalid command mnemonics or commands invalid due to context cause the command error bit to be set in the receiver's serial poll status word. If service requests are enabled, command errors also generate a service request.

DEVICE-DEPENDENT COMMANDS

REMOTE COMMAND	KEY
YS	YES or ENTER
NO	NO or CLEAR ENTRY
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
RS	START/RESET
MD	TIME MODE
RA	RATE
ES	ERR SEC
TO	TOTAL
FR	FRAME
PA	PATTERN
LV	LEVEL
TD (or 3)	TIME DISPLAY
TS (or 4)	TIME SET
CA (or 5)	TEST CATG
FN (or 6)	TEST FUNCTION
RT (or 7)	BASIC RETURN
SP (or 8)	STOP/PAUSE
CO (or 9)	CONTINUE
ST	None - returns receiver status
OD	None - outputs 40 char ASCII display
CL	None - reinitializes S5200D
RE	None - places S5200D in remote mode
LO	None - returns S5200D to local mode

5.4.5.2 COMMAND FORMATS AND FUNCTIONS

The table on the previous page provides a list of all RS-232-C or IEEE-488 (GPIB) remote commands, their function, and their corresponding front-panel pushbutton. The following subsections describe the commands individually.

YS COMMAND

The YS command performs the same function as the YES or ENTER pushbutton. It is used to enter time intervals and select categories and timed test modes.

NO COMMAND

The NO command performs the same function as the NO or CLEAR ENTRY pushbutton. It is used to deselect categories and test modes and clear entry errors during a time interval selection.

NUMERIC COMMANDS

The ASCII commands Ø-9 correspond to the front-panel Ø-9 pushbuttons. These commands are used to enter numeric parameters such as time-of-day and test time intervals.

RS COMMAND

The RS command corresponds to the front-panel START/RESET pushbutton. It is used to start or restart a test interval. In response to this command, all history status is cleared, all error accumulators are cleared, and the elapsed time clock is reset to Ø. The time mode (untimed, single, repeat, or single/repeat) does not change.

MD COMMAND

The MD command corresponds to the front-panel TIME MODE pushbutton. It is used to step through the four time modes to allow their selection. In response to the MD command, the S5200D stops the test in progress and prompts the user if he wishes to select the time mode currently selected. Issuing either the NO or MD commands cycles the S5200D to the next time mode (e.g. from UNTIMED to SINGLE) and displays a new prompt. Issuing the YS command selects the displayed time mode. If the selected time mode is single, repeat, or single/repeat, the user is prompted to enter the desired test time interval.

RA COMMAND

The RA command corresponds to the front-panel RATE pushbutton. It is used to display the current BIT or PARITY ERR RATE on the left side of the 40-character display. The current error rate is measured and recomputed over 10^8 bits and is updated approximately every 2.2 seconds.

ES COMMAND

The ES command corresponds to the front-panel ERR SEC pushbutton. It is used to displa BIT or PARITY errored seconds since the start of the test. Errrored seconds are displayed on the left side of the display.

TO COMMAND

The TO command corresponds to the front-panel TOTAL pushbutton. It is used to display total BIT, PARITY or BPV errors since the start of the test. When the total number of errors exceeds the 9-digit display capacity, the = sign in the display is replaced with a question mark. Totalized errors are displayed on the right side of the 40-character display.

FR COMMAND

The FR command corresponds to the front-panel FRAME pushbutton. It is used to toggle between FRAMED and UNFRAMED data stream monitoring. When FRAMED, the S5200D Receiver attempts to synchronize on the DS3 framing bits. Frame loss is reported via front-panel LEDs and is available to a remote controller via the ST command. When UNFRAMED, the S5200D Receiver assumes the input data stream is not a DS3 format signal. Parity a frame loss measurements have no meaning when the Receiver expects an unframed input dat stream.

PA COMMAND

The PA command corresponds to the front-panel PATTERN pushbutton. It is used to toggle between expecting a pseudorandom bit sequence (PRBS) or one of the three fixed short words as the input data stream pattern. Which of the three short words is selected depends on the setting of the 3-position rear-panel short word switch. The setting of the short word switch is not controllable remotely.

LV COMMAND

The LV command corresponds to the front-panel LEVEL pushbutton. It is used to select the input data level and source. Issuing the LV causes the Receiver to advance from the current level selection to the next. Four level select settings are provided as follows:

LEVEL SETTING	FUNCTION
DSX	B3ZS bipolar data are expected at the DS3 input jack. Signal levels correspond to the DSX cross-connect signal levels.
HIGH/LOW	B3ZS bipolar data are expected at the DS3 input jack. High/low range is 1.5V peak with nominal high level = .91V peak. Low level is 13.8 dB below high. "Low level sensivity" is sufficient for insertion losses 23 dB.
BINARY DATA & CLOCK	NRZ unipolar data are expected on the binary data BNC input jack. An external clock signal must be provided on the BNC clock input jack. Signal levels must be in the range of 1V peak-to-peak centered about ØV.
BINARY DATA ONLY	NRZ unipolar data are expected on the binary data BNC input jack. The S5200D recovers clock from this signal so no clock input is required. Signal levels must be in the range of 1V peak-to-peak centered about ØV.

TD COMMAND

The TD command corresponds to the front-panel TIME DISPLAY pushbutton. Successive TD commands cause the Receiver to cycle through its time displays based on the Receiver's

timed test mode. The sequence of displays is as follows:

TIME MODE	DISPLAY SEQUENCE
UNTIMED	elapsed time time-of-day
SINGLE	single elapsed time single remaining time single interval time-of-day
REPEAT	repeat elapsed time repeat remaining time repeat interval time-of-day
SINGLE/REPEAT	single elapsed single remaining single interval repeat elapsed repeat remaining repeat interval time-of-day

The basic return (RT) command returns the display to its basic display controlled by the basic display pushbuttons.

TS COMMAND

The TS command corresponds to the front-panel TIME SET pushbutton and allows the setting of time-of-day, single interval, or repeat interval depending on the current Receiver time mode. This mode may be exited only by entering a proper time-of-day or time interval followed by the YS command or by entering NO followed by a basic return (RT).

CA COMMAND

The CA command corresponds to the front-panel TEST CATEGORY pushbuttons. This command, in conjuction with the YS, NO, and FN commands, provides access to all measurement display functions (parity, bit, and BPV functions), access to the status functions, control of the audio (alarm functions), and control of printer outputs (print functions).

FN COMMAND

The FN command corresponds to the front-panel TEST FUNCTION pushbutton. This command is used in conjunction with the CA command to step through the display of all parity, bit, BPV and status measurements.

RT COMMAND

The RT command corresponds to the front-panel BASIC RETURN pushbutton. It is used to escape from many display sequences or prompts and return to the basic display. The basic display is determined by the RA, ES, and TO commands. The power-up basic display shows parity error rate and total parity errors.

SP COMMAND

The SP command corresponds to the front-panel STOP/PAUSE pushbutton. Issuing this command causes the S5200D to discontinue monitoring the input data stream and stop the test in process. The test may be resumed with the continue (CO) command or restarted with the RS command.

CO COMMAND

The CO command corresponds to the front-panel CONTINUE pushbutton. Halted tests may be resumed by issuing this command.

ST COMMAND

The ST command is used to acquire status from the S5200D Receiver. It has no corresponding front-panel pushbutton. Issuing the ST command causes the S5200D to snapshot its current status, as displayed by front-panel LEDs, and format and output an ASCII message which conveys that status.

OD COMMAND

The OD command is used to snapshot the current 40-character front-panel display and output it to the R3-232 interface. It has no corresponding front-panel pushbutton. Since commands are provided to display all S5200D measurement capabilities on the front panel, this command allows a remote controller to access all of those measurements.

CL COMMAND

The CL command is used to reinitialize the S5200D to its default power-up state. All error counters are cleared, status history is reset, and the S5200D is initialized to the UNTIMED, FRAMED, PRBS, DSX mode. The reinitialization phase requires about 2 seconds to complete. During this time, no further commands should be issued. The CL command clears the receiver before it has a chance to acknowledge the command. No "OK" or "WHAT?" response is generated when this command is received. The CL command has no corresponding front-panel pushbutton.

RE COMMAND

The RE command allows the user to put the S5200D under remote control. Under remote control, all front-panel pushbuttons are locked out. The REMOTE LED indicates that the S5200D is under remote control. This command has no corresponding front-panel pushbutton.

LO COMMAND

The LO command allows a remote controller to return the S5200D to local control. Under local control, front-panel pushbuttons are recognized. Remote commands issued under local control are also recognized. Hence, under local control, the controller and an operator may compete for control of the S5200D. This command has no corresponding front-panel pushbutton.

5.4.6 S5200D RECEIVER OUTPUT TO GPIB

Two device-dependent commands (ST and OD) may be used to request the S5200D receiver to output 40-character status or the current 40-character ASCII display. In addition, print functions may be selected and output routed to the GPIB port.

5.4.6.1 OUTPUT STATUS COMMAND

The output status command (ST) snapshots the same receiver status conveyed locally by 27 front-panel LEDs. When the S5200D is addressed to talk after the ST command has been issued, the status will be output to the bus DIO lines. The format of the ASCII status message is as follows:

STA=nn, HST=nn, TST=nn, FLV=nn, PAT=nn CR LF

STA-CURRENT STATUS

	MOST-SIGNIFICANT HEX DIGIT				LEAST-SIGNIFICANT HEX DIGIT			
	7	6	5	4	3	2	1	0
STA= nn	0 (unused)	0 (unused)	Remote Enabled	X-Bit Detected	Blue Signal Detected	Data Sync Loss	DS3 Frame Loss	Signal Loss

STA=nn provides the hexadecimal notation of the current status of the input signal and the status of the remote enable. A 1 in a bit position has the same meaning as the corresponding front-panel LED being lit.

HST-HISTORY STATUS

	MOST-SIGNIFICANT HEX DIGIT				LEAST-SIGNIFICANT HEX DIGIT			
	7	6	5	4	3	2	1	0
HST= nn	0 (unused)	0 (unused)	0 (unused)	Power Loss	Blue Signal Detected	Data Sync Loss	DS3 Frame Loss	Signal Loss

HST=nn provides the hexadecimal notation of the history (past) status of the input signal and power. A 1 in a bit position has the same meaning as the corresponding front-panel LED being lit. History status is reset when the history status LEDs are reset (power-on, start/reset, device clear, and test initialization).

TST-TEST MODE STATUS

	MOST-SIGNIFICANT HEX DIGIT				LEAST-SIGNIFICANT HEX DIGIT			
	7	6	5	4	3	2	1	0
TST= nn	0 (unused)	0 (unused)	Stop/ End	In Process	Single/ Rept	Repeat	Single	Untimed

TST=nn provides the hexadecimal notation of the test mode status. A 1 in a bit position has the same meaning as the corresponding front-panel LED being lit.

FLV-FRAMING AND LEVEL STATUS

	MOST-SIGNIFICANT HEX DIGIT				LEAST-SIGNIFICANT HEX DIGIT			
	7	6	5	4	3	2	1	0
FLV= nn	0 (unused)	0 (unused)	Binary data only	Binary data & clock	High/Low data	DSX data	unframed	DS3 framed

FLV=nn provides the hexadecimal notation of the input framing and signal-level status. A 1 in a bit position has the same meaning as the corresponding front-panel LED being lit.

PAT-PATTERN STATUS

	MOST-SIGNIFICANT HEX DIGIT				LEAST-SIGNIFICANT HEX DIGIT			
	7	6	5	4	3	2	1	0
PAT= nn	0 (unused)	0 (unused)	0 (unused)	0 (unused)	1010	1100	1111	PRBS

PAT=nn provides the hexadecimal notation of the input pattern. A 1 in a bit position has the same meaning as the corresponding front-panel LED being lit.

5.4.6.2 OUTPUT DISPLAY COMMAND

The output display command (OD) snapshots the current display. When the S5200D is addressed to talk, the 40-character ASCII display message will be output, terminated by a carriage return and line feed. Since all S5200D measurements can be displayed on the 40-character alphanumeric display, all measurement capabilities are available for output to a remote controller.

NOTE The S5200D receiver may take up to 325ms to update its display. A GPIB program should wait at least 325ms after a new display has been selected before issuing the "OD" command.

5.4.6.3 AUTOMATIC PRINT FUNCTIONS

Bit or parity error-second and summary measurements may be obtained by selecting receiver print functions and configuring the instrument to talk. These outputs are particularly useful when the receiver is in the talk-only mode, outputing to a listen-only printer. See Section 4.5.2 for a complete description of the printer functions.

5.4.7 SERVICE REQUEST AND SERIAL POLL RESPONSE

Several conditions detected in the S5200D receiver will cause it to request service of the GPIB controller. The ability of the receiver to request service may be inhibited by the rear-panel DIP switch as described in Section 5.4.3, GPIB option selection.

When the controller detects a service request, it should serial poll the receiver to determine if the receiver is requesting service and why. In response to a serial poll addressed to the S5200D receiver, the receiver will place its 8-bit GPIB status byte on the DIO lines. The receiver clears its status byte when it receives a serial poll disable (SPD) command. The GPIB status byte is also cleared on power-up and in response to device clear. Only the service request bit in the status byte is reset by an interface clear.

5.4.7.1 SERVICE REQUEST, GPIB STATUS BYTE

	MOST-SIGNIFICANT HEX DIGIT				LEAST-SIGNIFICANT HEX DIGIT			
	7	6	5	4	3	2	1	0
GPIB Status Byte	0 (unused)	RQS	0 (unused)	0 (unused)	Instr fail	Cmd error	Bus error	Talk request

The following receiver-detected conditions will cause it to request service (if SRQ is enabled):

Bus error.....Bus error occurs when the receiver is addressed to talk with no listeners active on the bus. Since a source handshake may have been started by the talking receiver with no acceptor to complete the handshake, this error may hang up the bus. This condition can be cleared and detected by the controller issuing an interface clear followed by a serial poll. The ON condition for the bit is 1.

Cmd error.....Command error occurs when the receiver detects an invalid device-dependent command as described earlier under Device-Dependent Commands. The command error bit is set in the GPIB status byte. The ON condition for the bit is 1.

Talk request.....When the S5200D receiver has data to output, but is not addressed to talk, it will generate a service request with the talk request bit set in the GPIB status byte. The ON condition

for the bit is 1. If configured to talk before serial polled, this bit will be cleared in the status byte. If no other bits are set, the service request will be deasserted.

Instr fail.....A software detected failure in the S5200D receiver will cause the instrument failure bit to be set in the GPIB status byte. Some instrument failures may not be recoverable by device clear functions. The only recourse, then, is to turn the receiver off and back on. The ON condition for the bit is 1.

The RQS bit is on (1) whenever one or more of the other bits (instr fail, cmd error, bus error, or talk request) is on and service requests have been enabled by DIP switch 1.

Multiple bits may be set in the status byte when it is polled. All bits are cleared following a serial poll.
Status displayed by front-panel LEDs is not available through the GPIB status byte acquired by serial polling. The receiver status may be obtained as described earlier under Output Status Command.

The receiver will not respond to parallel polling commands.

5.4.7.2 **SERIAL POLLING**

The GPIB status byte may be accessed from the S5200D receiver by serial polling as follows:

1. Issue 'UNT' universal untalk command.
2. Issue 'SPE' serial poll enable command.
3. Issue controller listen address.
4. Issue 'MTA' S5200D receiver talk address.
5. Receive 'STB' S5200D receiver status byte.
6. Issue 'UNT' or 'OTA' S5200D receiver untalk command.
7. Issue 'SPD' serial poll disable command.

NOTE A random loss of the RQS bit may occur after the receiver has generated a service request and has been polled. It is recommended that the user check for <u>any</u> bits set in the serial poll status word to determine if the receiver may have requested service.

5.4.8 SAMPLE GPIB CONTROL

Because of its microprocessor control, the S5200D receiver has very powerful data-monitoring and characterization capabilities. Not only can it provide total-errors and error-rate information, but it can categorize the data according to five rate thresholds (dribbling, E-6, E-5, E-4, and E-3). It can also provide totalized information by error-second and summary information over programmable timed test intervals.

5.4.8.1 RECEIVER MODE CONTROL

If the user is familiar with the S5200D receiver front panel and has operated the instrument manually, then he will find that controlling it by GPIB is very simple. The commands provided for remote control exactly imitate the front-panel push-buttons. All the user has to do is note the proper sequence of pushbuttons to select a function manually, and then generate the corresponding set of remote commands.

For example, when the S5200D receiver is powered-on, it begins taking measurements in the untimed mode and assumes the signal is a DS3 framed, pseudorandom bit sequence at the DSX signal level. To stop taking measurements manually, the user simply pushes the STOP/PAUSE button. Under remote control, he would issue the 'SP' command. To continue, the 'CO' command has the same function as the CONTINUE button. A list of the remote commands and corresponding front-panel pushbuttons is given in Section 5.4.5.

The S5200D receiver will respond to remote commands by GPIB only after it has been addressed to listen. The controller must place the receiver's listen address on the parallel data lines DIO 1 thru 8 with the ATN attention line asserted to configure the receiver to listen. If the REN remote-enabled line is also asserted, the receiver's REMOTE LED will light, ignoring any front-panel push-button commands. When the receiver has been addressed to listen, data placed on the bus with ATN deasserted will be accepted and interpreted as device-dependent commands (listed in detail under Device-Dependent Commands, section 5.4.5).

The following example illustrates how GPIB can be used to select a 30-second repeat test:

1. Set the rear-panel DIP switches as follows to enable service requests and set the talk address as 42 (hex) and the listen address as 22 (hex):

Switch:	1	2	3	4	5	6	7	8
Setting:	ON	OFF	OFF	OFF	OFF	OFF	ON	OFF

2. Assert REN line.

3. Assert ATN line and issue listen address.

4. Issue MD, MD, MD, YS command sequence to select the REPEAT mode (assuming receiver was originally in the untimed mode). Note that this sequence is identical to the manual sequence of pushing the TIME MODE button three times and then pushing the YES button.

5. Issue 3, 0, YS command sequence to select a 30-second repeat interval. Note that this sequence is identical to the manual sequence of pushing the 3 button, the 0 button, and the ENTER button.

6. The 30-second repeat test can be synchronized to other GPIB-controlled equipment by issuing a group-execute trigger GPIB command (assert ATN and place 08 hex on the data lines).

Note that the command sequences are output one character at a time and must be terminated by a carriage return and line feed.

Any other receiver functions (selecting framing, pattern, signal level, setting time-of-day, selecting printer outputs, etc.) can be commanded remotely. The easiest way to do this is to set up the receiver manually, noting each button pushed. The buttons pushed can then be translated into their corresponding commands using the table given under Device-Dependent Commands.

5.4.8.2 GETTING DATA FROM S5200D RECEIVER

Remote control is not very useful if data cannot be returned to the controller for analysis and/or display. The receiver places data on the bus only after it has been addressed to talk. If it has no data to put on the bus, one or two null bytes (00 hex) are placed on the bus and the EOI signal is asserted. The controller must be listening when the receiver is addressed to talk.

The S5200D receiver provides three output capabilities:

Receiver status
Front-panel display
Automatic print functions

5.4.8.2.1 **RECEIVER STATUS**

The status displayed on the front panel of the receiver can be returned to the GPIB controller in the 40-character ASCII message described in section 5.4.6.1, Output Status Command, by the following command sequence:

1. Address receiver to listen.
2. Issue 'ST' command.
3. Tell receiver to unlisten.
4. Address controller to listen.
5. Address receiver to talk.
6. Receive 40-character ASCII display terminated by a carriage return and line feed.

A typical status message is as follows:

```
STA=17. HST=07. TST=11. FLV=05, PAT=01
```

It is interpreted, with the aid of Section 5.4.6.1, as follows:

STA=17.....Current status: Remote disabled, X-bit detected, no blue signal detected, data sync loss, DS3 frame loss, and signal loss.

HST=07.....History status (the following events have occurred): no power loss, no blue signal, data sync loss, DS3 frame loss, and signal loss detected.

TST=11.....Test Mode status: Untimed test in progress.

FLV=05.....Framing and Level status: Framed data at DSX signal level is expected.

PAT=01.....Pattern status: Pseudorandom bit sequence input is expected.

5.4.8.2.2 FRONT-PANEL DISPLAY

The capability to control and snapshot the front-panel display allows a GPIB controller to acquire any of the S5200D receiver's various measurements. The front-panel TEST CATEGORY and TEST FUNCTION buttons provide the local capability to control what is displayed. Corresponding 'CA' and 'FN' commands allow remote control of the display.

When the receiver receives an 'OD' command, the current 40-character ASCII display is snapshot and queued for output. When the receiver is addressed to talk, the message, terminated by a carriage return and line feed, is output one character at a time. This message may be displayed as is, or the data may be extracted from it and analyzed by the controller. A typical command sequence to select a display, snapshot it, and return it to the controller, is as follows:

1. Issue the S5200D receiver's listen address.
2. Issue a CA, CA, FN, FN, FN CR LF command sequence to configure the display to show bit error-seconds and total bit errors.
3. Wait at least 325ms for the display to change to the selected functions.
4. Issue OD command to snapshot display.
5. Issue unlisten command.
6. Address controller to listen.
7. Address receiver to talk.
8. Receive the message terminated by a carriage return and line feed. A typical message is as follows:

   BIT ERR SEC= 22,TOTBIT ER= 28913523

5.4.8.2.3 AUTOMATIC PRINT FUNCTIONS

The print functions available through the category and function commands provide the following output capabilities:

- Automatic error-second output when bit or parity errors detected.
- Automatic bit or parity summary output at the end of a timed interval.
- Bit or parity summary output on demand.
- Reporting of lost data buffers.
- Automatic squelch on excessive errors.

Print functions are more completely described in Section 4.5.2, Printer Output.

The following command sequence selects bit error-second and summary print functions for a 60-second single test:

1. Address the S5200D receiver to listen.
2. Issue a CA, CA, CA, CA, CA, CA CR LF command sequence to select the print category.
3. Issue YS to select print functions.
4. Issue NO to deselect immediate summary (summary on demand).
5. Issue YS to enable automatic summary.
6. Issue NO to deselect parity output.
7. Issue YS to select bit outputs.
8. Issue YS to select error-second outputs.
9. Issue NO to disable automatic squelch.
10. Issue MD, MD, YS to select single test mode.
11. Issue 6, 0, YS to select 60-second interval.
12. Issue unlisten command.
13. Address controller to listen.
14. Address S5200D receiver to talk.
15. Receive automatic outputs as they are generated. Note that a stream of two null bytes with EOI is output when no print messages are ready to be output. With service requests enabled, the receiver will generate a service request when it has data to be output. A typical printout is as follows:

```
5-05:50:26 Bit= 7921043,SigLoss    X
5-05:50:29 Bit=22982427     SyncBlu
5-05:50:30 Bit= 4273368     SyncBlu
5-05:50:33 Bit=17717050,FrmSync    X
5-05:50:39 Bit=        5
5-05:50:42 Bit=     4420
5-05:50:43 Bit=      988             X
5-05:50:46 Bit=       45
5-05:50:47 Bit=       27
5-05:50:51 Bit=       45
5-05:50:52 Bit=       44
5-05:50:53 Bit=       45                A C
5-05:50:54 Bit=       10
5-05:51:07 Bit=        1

5-05:51:17   END INTERVAL   BIT  SUMMARY
Elapsed Time=00-00:01:00  (60       Secs)

Bit Errs=52900318     AvgErrRate =2.0E-02
Err Secs=14           %ErrFreeSec=76.6666
DribErrs=43           DribErrRate=1.6E-08
THRESHOLD ERRORED SEC SUMMARY:
     E-6=10           E-4=5
     E-5=6            E-3=4
STATUS AND EVENT SECONDS:
SigLs=1        Frame=3        Sync=5
 Blue=2        X-Bit=5           A=1
    B=0            C=1           D=0
```

Section 6, Performance Verification

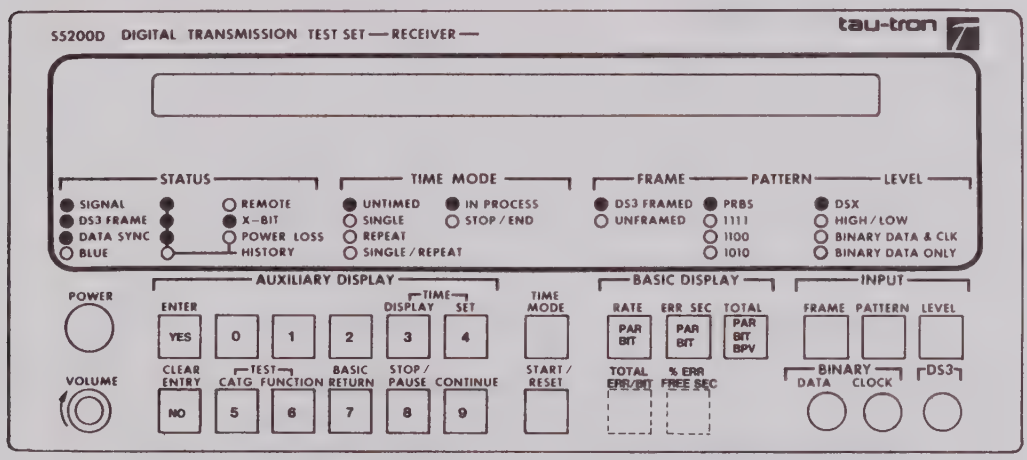
6.1 RECEIVER PERFORMANCE VERIFICATION

These tests should be performed with the S5200D receiver alone to provide a partial check of its operation. They verify the operation of the majority of functions performed by the error counter circuits, timing circuits, front-panel control, displays, power supplies, and software.

More thorough checks, particularly of the B3ZS decoder and PR sync circuits, require an S5200D transmitter. These checks are included in the Receiver Performance Verification with Transmitter section.

The verification checks are:

Power-up state
Time mode set
Parity function summary
Time-of-day set



6.1.1 POWER-UP STATE

1. Turn POWER on. Verify "power-up" state of LEDs as shown above. Display will read.

PAR ERR RATE = xx TOTPAR ER= xx

NOTE When the alphanumeric display numerals are given as "xx", the actual values shown are not important. If this condition is not obtained, refer to the Service section.

6.1.2 TIME MODE SET

1. Push TIME MODE twice so display reads:

   DO YOU WANT SINGLE MODE? YES or NO (blinking)

   Observe TIME MODE red STOP/END LED on.

2. Push YES. Observe:
   TIME MODE yellow SINGLE indicator on and display reading:

   SELECT + ENTER SNGL INTERVAL= 00-00:00:01
   (days-hours: minutes: seconds, blinking 10's of seconds)

3. Push 1 to set 10's of seconds to 1, push 0 to set seconds to 0.

4. Push ENTER to set in the 10-second test just defined. TIME MODE green IN PROCESS indicator will light and display will read:

   PAR ERR RATE= xx TOTPAR ER= xx

5. At the end of 10 seconds the TIME MODE red STOP/END indicator will light and the display will stop changing.

6.1.3 PARITY FUNCTION SUMMARY

1. Push the TEST CATEGORY button and observe the display:

   DO YOU WANT PARITY FUNCTIONS? YES or NO (blinking)

2. Push YES and observe the display:

   PAR ERR RATE = xx TOTPAR ER= xx

3. Repetitively push TEST FUNCTION. Display will read:

AVG PAR ERR RATE= xx	00-00:00:10
% PAR ERR FREE SEC= 00.000	00-00:00.10
PAR ERR SEC= 10	TOTPAR ER= xx
PAR Er Sec E-3= INVALID	" " " "
PAR Er Sec E-4= 0	" " " "
PAR Er Sec E-5= 10	" " " "
PAR Er Sec E-6= 10	" " " "
PAR DRIB TOT= 0	" " " "
PAR DRIB RATE= 0.0E-12	" " " "

4. Push BASIC RETURN.

6.1.4 **TIME OF DAY SET**

1. Push TIME MODE four times or until display reads:

   DO YOU WANT UNTIMED MODE? YES or NO

2. Push YES.

3. Push TIME SET. Observe the display:

   SELECT + ENTER TIME OF DAY 04-20:11:00

   (days-hours:minutes:seconds, tens of hours blinking)

4. Enter correct time of day and day of week, e.g.: Sun=1, Mon=2.
   If a mistake is made, the CLEAR ENTRY button will backspace the cursor.

5. Push ENTER. The display will show the previous parity information.

6.2 RECEIVER PERFORMANCE VERIFICATION WITH TRANSMITTER

These tests must be made with an S5200D transmitter and, together with the Receiver Performance Verification test of the previous section, provide a more thorough check of the receiver operation.

It is required that the checks of section 6.1. Receiver Performance Verification be done before the checks of this section.

The verification checks are:

Frame and PRBS synchronization
Bit function summary
Status function summary
Binary signal

Transmitter Settings

Refer to the S5200D transmitter manual. Make the following transmitter front and rear-panel settings:

1. Turn power on.
2. Front panel:

   LEVEL.....DSX
   PATTERN.....PRBS
   FRAME.....DS3 FRAMED
   ERROR MODE....ERROR FREE

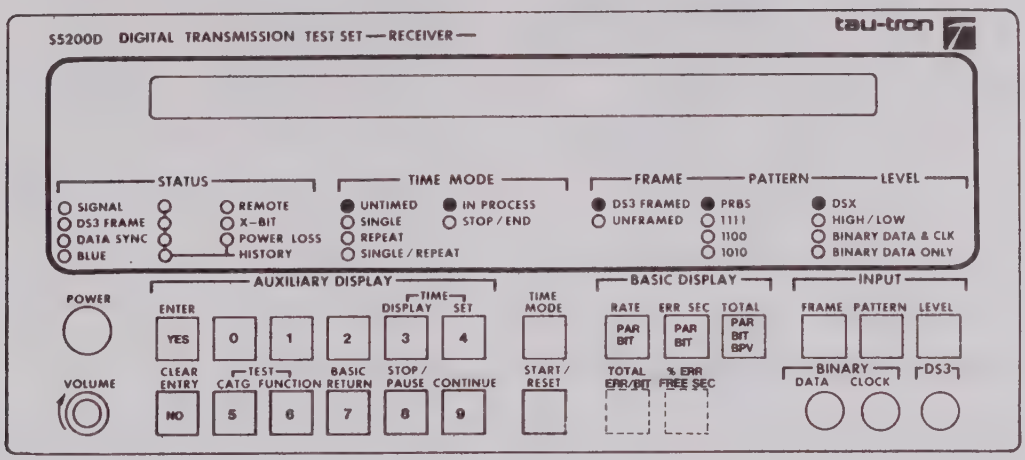
3. Rear panel:

   SHORT WORD....1010

6.2.1 FRAME AND PRBS SYNCHRONIZATION

1. Turn receiver POWER on.
2. Set receiver rear-panel short word to 1010.
3. Connect transmitter DS3 OUTPUT to receiver DS3 INPUT.

4. Push START/RESET. Verify LED's as shown



Verify the display:

PAR ERR RATE= 0.0E-08 TOTPAR ER= 0

If this condition is not obtained and the receiver has passed all checks in Section 6.1, then the trouble is in the transmitter. Check the Service section for the transmitter.

6.2.2 **BIT FUNCTION SUMMARY**

1. Change transmitter ERROR MODE to ERROR RATE, 10^{-5}.
2. Set a 10-second Single TIME MODE (refer to Time Mode Set of Section 4.4).
3. Push TOTAL button so that the right half of the display reads:

   TOTBIT ER= xx
4. Push BASIC DISPLAY RATE button so that the left half of the display reads:

   BIT ERR RATE= xx
5. Push START/RESET button to initiate test. At the end of 10 seconds, red TIME MODE STOP/END indicator will light (indicating the end of the 10-second test) and display will read:

   BIT ERR RATE= 1.0E-05 TOTBIT ER= 4421 (±3 counts)
6. Push TEST CATG twice and observe display:

   DO YOU WANT BIT FUNCTIONS? YES or NO

7. Repetitively push TEST FUNCTION and observe display:

BIT ERR RATE= 1.0E-05	TOTBIT ER= 4421(±3 counts)
AVG BIT ERR RATE= 1.0E-05	00-00:00:10
% BIT ERR FREE SEC= 00.000	00-00:00:10
BIT ERR SEC= 10	TOTBIT ER= 4421 (±3 counts)
BIT Er Sec E-3= 0	" " " " "
BIT Er Sec E-4= 0	" " " " "
BIT Er Sec E-5= 9 or 10	" " " " "
Bit Er Sec E-6= 10	" " " " "
BIT DRIB TOT= 0	" " " " "
BIT DRIB RATE= 0.0E-12	" " " " "

8. Push BASIC RETURN.

6.2.3 STATUS FUNCTION SUMMARY

1. Change transmitter front-panel PATTERN to 1010, FRAME to UNFRAMED, and ERROR MODE to ERROR FREE.

2. Push START/RESET to initiate test. At the end of 10 seconds, the red TIME MODE STOP/END indicator will light.

3. Push TEST CATG repetitively until the display reads:

   DO YOU WANT STATUS FUNCTIONS? YES or NO

4. Push TEST FUNCTION repetitively and observe:

   Sig Loss SEC= 0
   Fram Loss SEC= 10
   Sync Loss SEC= 10
   Blue Sig SEC= 0
   X-Bit SEC= x (greater than zero)
   Extrnl A SEC= 0
   Extrnl B SEC= 0
   Extrnl C SEC= 0
   Extrnl D SEC= 0

6.2.4 BINARY SIGNALS, CLOCK AND DATA

1. Change transmitter PATTERN to PRBS, FRAME to DS3 FRAMED.

2. Disconnect transmitter DS3 OUTPUT from receiver DS3 INPUT.

3. Connect a 75ohm BNC cable from the transmitter BINARY OUTPUT DATA to the receiver BINARY DATA.

4. Connect a 75ohm BNC cable from the transmitter BINARY OUPUT CLOCK to the receiver BINARY CLOCK.

5. Turn receiver POWER off then on to return receiver to power-up state.

6. Push receiver INPUT LEVEL twice and observe yellow BINARY DATA & CLK on.

7. Push receiver START/RESET. No receiver STATUS indicators will be lit.

8. Push transmitter ERROR CONTROL SINGLE BIT. The TOT PAR ER display will accumulate a count each time button is pushed.

6.2.5 BINARY SIGNALS, DATA ONLY

1. Disconnect transmitter BINARY OUTPUT CLOCK from receiver BINARY CLOCK. Push receiver INPUT LEVEL for BINARY DATA ONLY indication.

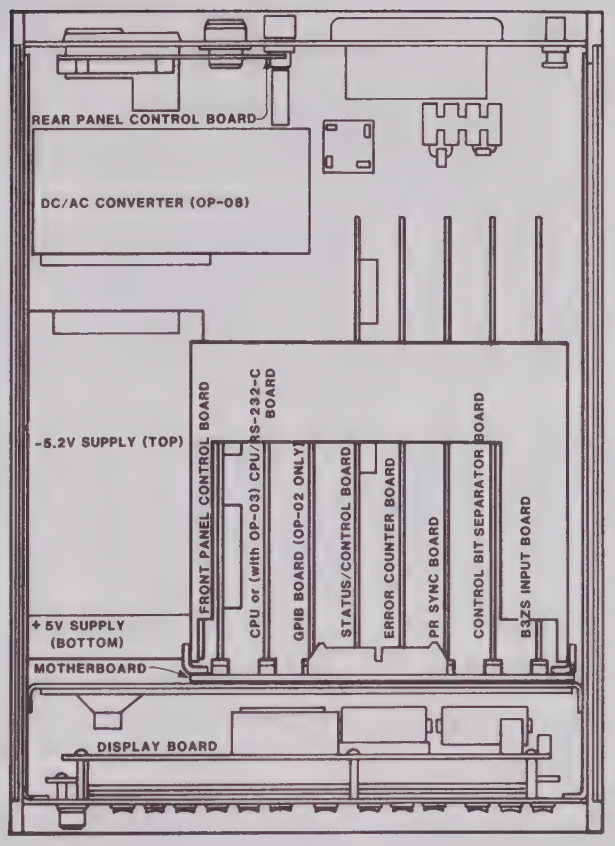
2. Push receiver START/RESET. No receiver STATUS indicators will be lit.

3. Push transmitter ERROR CONTROL SINGLE BIT. The TOT PAR ER display will accumulate a count each time button is pushed.

Section 7, Theory of Operation

7.1 GENERAL

The S5200D receiver consists of seven plug-in printed circuit boards, a front-panel display board, and a rear-panel printed circuit board. Refer to system block diagram. If Option 02, IEEE-488 Interface is installed, an additional plug-in circuit board is installed. Two power supplies are used, a +5V supply at 12A and a -5.2V supply at 6A. An optional DC power converter allows operation from either -24 or -48VDC, or 115VAC.



The eight plug-in boards are divided into two sections:

High-Speed section:

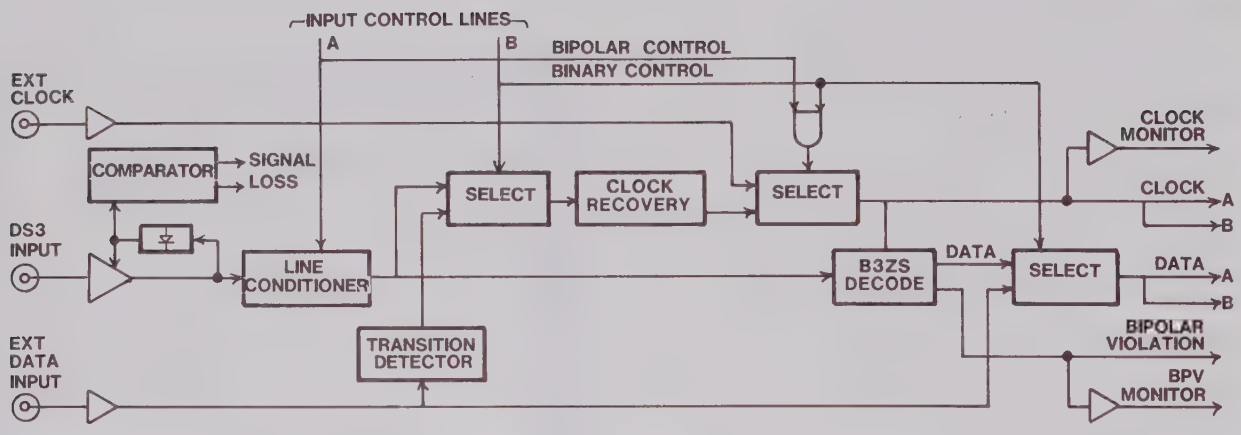
- B3ZS Input board
- Control Bit Separator board
- PR Sync board
- Error Counter board

Software/Hardware section:

- Status and Control board
- GPIB board (OP-02 only)
- CPU board or, with OP-03,
- CPU/RS-232-C board
- Front-Panel Control board

All eight plug-in boards plug into a mother board which is also divided into the same two sections, high-speed and software/hardware. The software/hardware section is an STD 8-bit microprocessor system bus.

7.2 B3ZS INPUT BOARD



When the input is selected for either DSX3 or DSX Hi/Lo, the DS3 signal goes through an AGC amplifier that works with an input signal level about 30dB below the normal DSX3 cross-connect level. The signal from the AGC amplifier is converted to RZ data which is then fed to a phase-locked loop for timing recovery. The RZ data and timing information are sent to the B3ZS decoder where it is converted to NRZ data and sent to the Control Bit Separator and PR Sync boards. The recovered timing information is also sent to a rear-panel monitor BNC connector.

The B3ZS board also detects bipolar violations (BPV) in the B3ZS signal. The BPV output is sent to the Error Counter board and the BPV output connector on the rear panel.

When the Binary Data and Clock format are selected, the AGC amplifier and phase-locked loop are by-passed.

The no-signal alarm is generated on the B3ZS Input board and applied to the Status and Control board where it is read by the system software and displayed on a front-panel indicator.

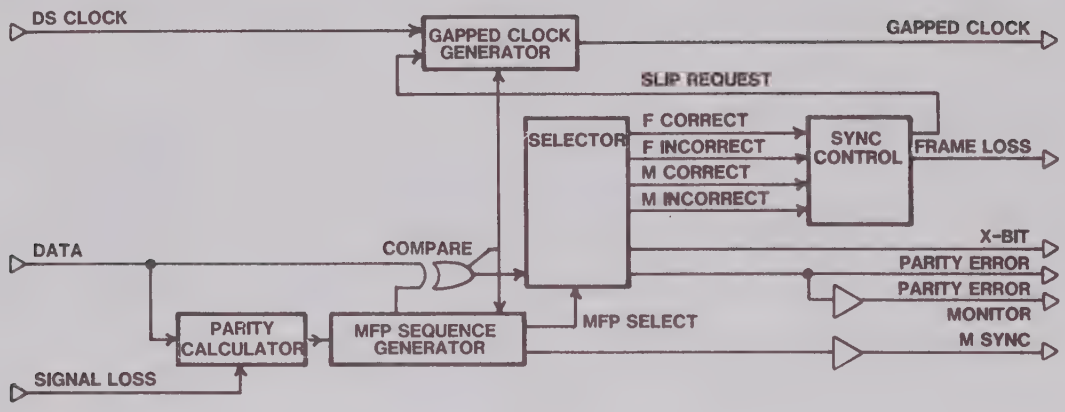
The B3ZS Card can be strapped for different binary data and clock input options. There are four jumper plugs located in the lower left hand corner of the card when observing the component side with the connector fingers to the left.

The clock jumper is labeled EXT CLK and is normally in the OV, TTL position. It is AC coupled and this position provides operation at OV or TTL thresholds with a

75 ohms-to-ground input. Moving this jumper to the ECL position, which is just above the OV, TTL position, provides a 75 ohms to -2V input and operation at ECL thresholds.

The three jumpers to the right of the clock jumper are grouped and labeled EXT DATA. One of the jumpers is labeled DC and provides DC coupling of data input. If this jumper is removed, the data AC coupling is provided. The remaining two jumpers are normally in the OV position providing OV threshold and a 75ohm input to ground. The TTL position requires moving one of these jumpers to provide TTL thresholds, 75 ohms-to-ground input. ECL thresholds, 75 ohms to -2V input requires moving both jumpers from the normal position to that labeled ECL.

7.3 CONTROL BIT SEPARATOR BOARD



The Control Bit Separator board is used only when the receiver is in the framed mode of operation.

The inputs to the module are the 44.736Mb/s data and the timing from the B3ZS Input board. The output is a 44.2MHz gapped clock that is sent to the PR Sync board.

The Control Bit Separator board locates the DS3 frame information, counts parity on the incoming data and compares it to the transmitted parity bit, and generates parity errors whenever the parity bits do not compare. It also removes the information data from the DS3 signal and sends it to the PR Sync board. The parity errors are sent to the Error Counter board and to the rear-panel connector.

MASTER FRAME DATA FORMAT

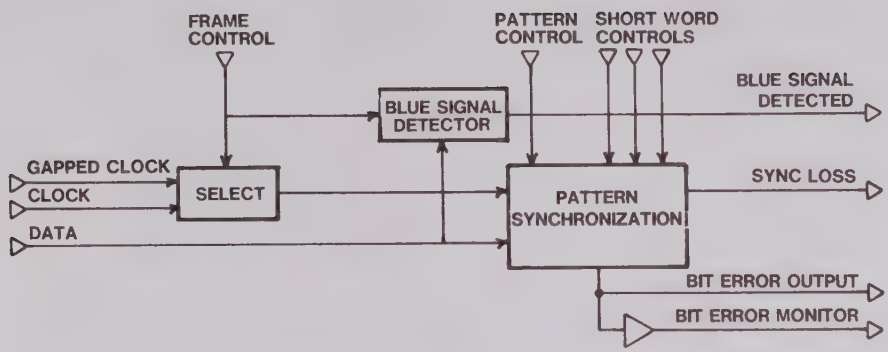
SUB FRAME													
1	X	FI	C11	FO	C12	FO	C13	FI
2	X	FI	C21	FO	C22	FO	C23	FI
3	P	FI	C31	FO	C32	FO	C33	FI
4	P	FI	C41	FO	C42	FO	C43	FI
5	MO	FI	C51	FO	C52	FO	C53	FI
6	MI	FI	C61	FO	C62	FO	C63	FI
7	MO	FI	C71	FO	C72	FO	C73	FI

– 84 INFORMATION BITS BETWEEN FRAME OR HOUSEKEEPING BITS

- M FRAME IS ALL 56 FRAME BITS AND 4704 INFORMATION BITS, TOTAL 4760 BITS.
- FRAME ALIGNMENT SIGNAL IS FI = I, FO=O.
- MULTI-FRAME ALIGNMENT SIGNAL IS MO,MI,MO (MO=O,MI=I).
- PARITY INFORMATION IS PP AND IS TAKEN OVER ALL INFORMATION BITS IN THE PRECEDING M FRAME PP=I IF THE SUM OF ALL INFORMATION BITS IS I, PP= O IF THE SUM IS O.
- ALARM SERVICE CHANNEL IS XX. IN ANY ONE M FRAME THE TWO X-BITS MUST BE IDENTICAL.
- STUFFING INDICATOR WORD IS THE C-BITS.
- INFORMATION BITS WITH S5200D-TX CAN BE $2^{15}-1$ PSEUDORANDOM SEQUENCE . WITH LIVE TRAFFIC IT IS SEVEN 6.312 MB/S DATA SOURCES.

The Control Bit Separator board also generates the out-of-frame signal and the X-bit signals. These signals are sent to the front-panel status indicators and to the rear-panel monitor connector.

7.4 PR SYNC BOARD



The PR Sync board synchronizes to the incoming data and searches for errors in the data.

The board consists of a 2^{15}-1 pseudorandom sequence generator, a clock-select circuit, a blue-signal detector, and a data-sync circuit.

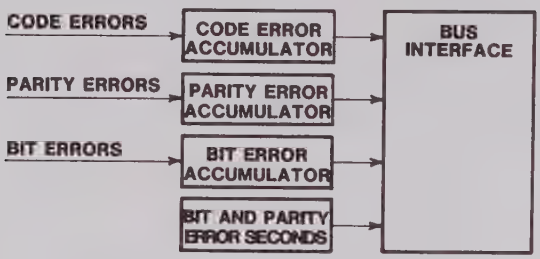
When in the unframed mode the input is a 44.736Mb/s data and timing signal from the B3ZS Input board. The data input is a 2^{15}-1 pseudorandom sequence that is generated by the S5200D transmitter. The data are forced into the 2^{15}-1 sequence generator to synchronize the generator to the incoming data pattern. When the generator is synchronized, it will be forced into its free-running mode. At this time the incoming data is compared to the sequence generator data on a bit-by-bit basis. Whenever any bit does not compare, a bit error is generated and sent to the Error Counter board.

When in the framed mode, the operation is the same except the timing input is selected from the Control Bit Separator board. This timing input is the DS3 clock except it has a pulse missing every 85th clock pulse. The missing pulse represents the frame information in the DS3 format. This timing input, called the gapped clock, reads the 2^{15}-1 data pattern into the sequence generator but, because of the missing clock pulse, it does not read the frame information into the sequence generator.

The PR Sync board also detects the blue signal in the framed mode of operation. The blue signal is a 1010 signal every 84 bits followed by one frame bit. When the receiver is monitoring live traffic, the only function of the PR Sync board is detection of the blue signal.

The sync-loss alarm and blue-signal detected signals are generated by the PR Sync board and sent to the Status and Control board where they are read by the system software and displayed on the front-panel status indicators.

7.5 ERROR COUNTER BOARD

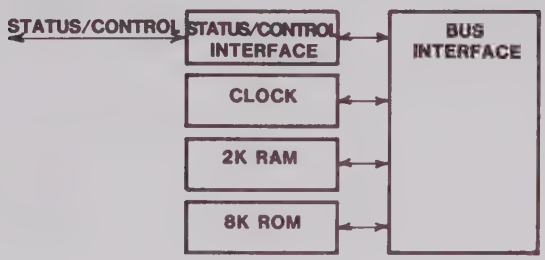


The Error Counter board contains the accumulators for counting the bit-errors, parity errors, bipolar violations, bit error-seconds, and parity error-seconds. Bit errors from the PR Sync board are counted by a 2^{24} (16,777,216) bit binary counter on the Error Counter board. The counter is a ripple type counter that consists of three 8-bit words. Each 8-bit word is latched by the microprocessor software into a storage register located on the Error Counter board. the storage register is addressed by the microprocessor and the 8-bit words are read onto the microprocessor bus through the bus interface circuitry.

The bipolar violations from the B3ZS Input board are also counted by a 2^{24} binary counter that operates in the same way as the bit-error accumulator.
Parity errors come in at a much lower rate than bit errors or bipolar violations so that a 2^{8} (256) bit counter is used.

Bit-error seconds and parity-error seconds are also generated on the Error Counter board and both operate in the same way. When an error is detected, a one-second timer is released. At the end of one second an error flag is set. When the flag is high, the microprocessor reads it as an error second, resets the flag low, and adds a count to the error-second accumulator in the software.

7.6 STATUS AND CONTROL BOARD



The Status and Control board is part of the software/hardware section and interfaces to the 8-bit microprocessor STD bus through the 56-pin edge connector on the front of the board. The other connectors interface with the Status and Control bus and the rear-panel printed circuit board.

The time-of-day clock is located on the Status and Control board. Its only function is to maintain the time of day. The test time is controlled by the microprocessor and is not related to the time of day clock. The time-of-day clock is useful when the receiver is operating in the printer mode to correlate time of day with errors on the hard-copy printout.

The board contains locations for 2k bytes of RAM and 8k bytes of ROM for the system software. Of the 2k of RAM, 1k is non-volatile and derives its power from three 1.2V batteries when the receiver loses its primary power input. The receiver status is fed into the 1k RAM on power loss. When power is restored, the microprocessor reads the contents of the 1k RAM and places the receiver in the same mode it was in before power was lost.

The Status and Control board receives the status information (signal loss, frame loss, blue signal, etc.) from the high-speed boards and applies it to the 8-bit microprocessor bus. The microprocessor then turns on the proper front-panel indicators, counts, and displays, in seconds, the time the alarm was active.

The Status and Control board also receives the four event inputs (A, B, C, and D) from the rear-panel monitor connector and applies them to the bus for display on the front-panel 40-character display.

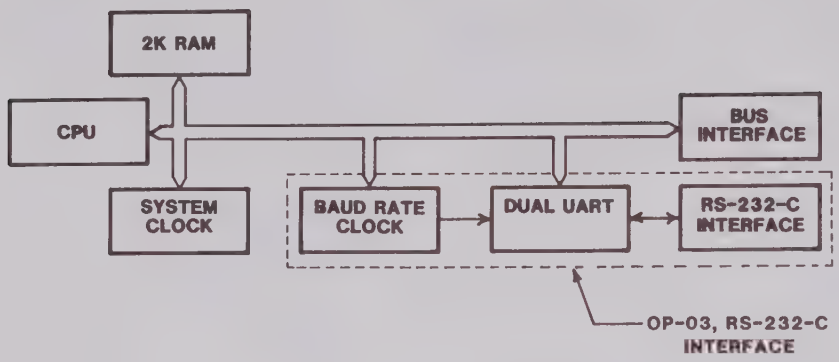
The operational mode, frame, pattern, and level of the receiver is controlled by the microprocessor through the Status and Control board. When an operational mode is selected by a front-panel pushbutton, the information is applied to the Statu

and Control board through the STD bus. This information is converted to the proper logic signal levels by the Status and Control board and sent to the Status and Control bus to control the high-speed boards. The level DSX3, hi/lo, data only, and data and clock are sent to the B3ZS Input board. The frame information is sent to the Control Bit Separator board and the pattern information is sent to the PR Sync board.

In addition, four DIP switches or jumper blocks on this board provide configuration information to the S5200D software. Switch settings and meanings are shown below:

SWITCH	JUMPER BLOCK	MEANING
S1-1 OFF	D OUT	Halt on software detected failure
S1-1 ON	D IN	Restart on software detected failure
S1-2 OFF	C OUT	No RS-232-C receive capability
S1-2 ON	C IN	RS-232-C receive capability
S1-3 OFF	B OUT	No RS-232-C XMIT capability
S1-3 ON	B IN	RS-232-C XMIT (printer) capability
S1-4 OFF	A OUT	Mostek CPU board installed
S1-4 ON	A IN	Tau-Tron CPU board installed

7.7 CPU BOARD



The CPU board performs the central processing functions and the serial interfacing function (if Option 03, RS-232-C is installed).

The CPU uses a Z80 microprocessor and generates all the signals used to control the 8-bit STD bus. The input/output of the bus is through a 56-pin edge connector on the front of the module.

The board contains the microprocessor system 2.4576MHz clock, 2k of RAM used for system software, the Z80 microprocessor, and the input/output bus interface circuitry.

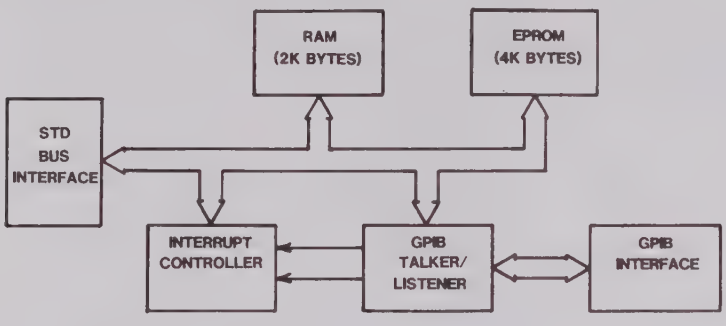
Some receivers may have the CPU-only board in which case the RS-232-C interface will not have been installed.

The RS-232-C serial interface is an option and when installed the circuitry that controls the interface is located on the CPU board.

The information from the 8-bit microprocessor bus is fed into a Universal Asynchronous Receiver Transmitter (UART) and fed out of the UART in serial form to the RS-232-C level interface circuitry.

The output baud rate of the interface is set by a baud-rate 8-section DIP switch located on the rear panel of the unit.

7.8 **GPIB BOARD** (option 02, IEEE-488 Interface only)

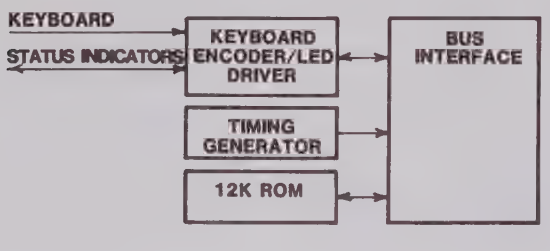


This board is installed as part of OP-02, GPIB Interface. It provides the interface between the GPIB connector and the microprocessor. Most of the implemented GPIB functions are handled by a 40-pin GPIB talker/listener LSI IC under microprocessor control. GPIB program memory, read/write variables, and output buffer RAM reside on this board.

Four LEDs on this board indicate GPIB status. They are labled with single-character indentifiers and have the following meanings.

LABEL	MEANING
T	ON when addressed to talk
L	ON when addressed to listen
R	ON when under remote control
S	ON when S5200D is requesting service

7.9 FRONT-PANEL CONTROL BOARD



The Front-Panel Control board is part of the software/hardware section and interfaces to the 8-bit microprocessor bus through the 56-pin edge connector on the front of the board. The other connectors interface with the 40-character display and the front-panel pushbutton assembly.

The board contains 12k of EPROM that is used for part of the system software. It receives error information from the error counter and receives status information from the Status and Control board by the STD bus and applies it to the front-panel 40-character display for readout.

The Front-Panel Control board also accepts information from the front panel. Whenever a button is pushed, the board sends the information over the STD bus to perform the proper function within the system.

7.10 SOFTWARE THEORY OF OPERATION

Under software control, the Z80 microprocessor adds powerful computational and interface capabilities to the S5200D receiver. Specifically, the software performs the following S5200D functions:

Handling front-panel controls and displays
Controlling high-speed hardware
Reading error accumulators
Updating totals and computing error measurements
Handling remote interfaces.

Front-Panel Control And Display Software

Front-panel pushbutton select processing is implemented as a state machine, enabling multiple functions to be assigned to individual buttons. In response to a button select interrupt, the button I.D. is saved for processing by the handler task. The handler task runs every 325ms, responds to prior button selects by updating the software state, and calls subroutines to update the alphanumeric display and status LEDs. Measurement display updates thus occur at a rate of once every 325ms, or approximately three times per second.

Hardware Control Software

In response to power-up, front-panel pushbutton selects or remote commands, control data may be written out to hardware control latches. Software starts and stops timed measurement modes, clears error counters, and sets input signal characteristics (framing, pattern, and signal level).

Measurement Monitoring Software

Bit, parity, and bipolar-pulse-violation (BPV) error counters, and error-second indicators are read every 25ms by measurement monitoring software. These raw measurements are used in conjunction with software maintained elapsed test time to compute the remainder of the error characterization measurements (i.e., error-rates, threshold error-seonds, percent error-free seconds, etc.). Software provides 32-bit counters for bit, parity, and BPV errors, allowing more than 4×10^9 errors before overflow. If overflow does occur, the displayed = is replaced with a ? for affected measurements. Measurement computations are performed every 325ms in conjunction with display updates.

Remote Interface Software

With options OP-02 or OP-03, GPIB or RS-232-C interface software is provided. GPIB software permits a GPIB remote controller to set up any of the S5200D test modes and acquire any of its measurement data. Buffering of 1024 bytes is provided to hold output data until a controller is ready to read it. The RS-232-C software provides for output of S5200D print functions. Printer output software formats ASCII print buffers and queues them for output. In response to interrupts, buffers are transferred to GPIB and/or RS-232-C interface hardware one character at a time.

Section 8, Service

8.1 ASSISTANCE

For service assistance call the Tau-Tron Customer Service Dept., (617)256-9013. Their experience and expertise can often save you valuable time in correcting any equipment malfunction.

8.2 REPAIR RETURNS

To return a unit for repair:

1. Call the Customer Service Dept., (617)256-9013, for a Repair Authorization Number. This will reduce administrative delays and ensure prompt return of your unit.
2. Complete and attach the Repair Tag, in the rear of the manual, to your unit for positive identification.
3. Pack the unit in the original shipping carton and packing materials, if available. Otherwise use a double-walled carton (test strength of 350 lb) and pack securely to prevent any movement in the carton during transit. Secure the carton by sealing with heavy paper tape.
4. Send to : Tau-Tron
   27 Industrial Ave.
   Chelmsford, MA 01824
   Attn: Customer Service

8.3 ROUTINE SERVICE

WARNING Do not attempt access to rear-panel air filter without disconnecting the line cord from the power receptacle.

Air Filter Periodically clean the rear-panel air filter to maintain proper air flow for adequate cooling:

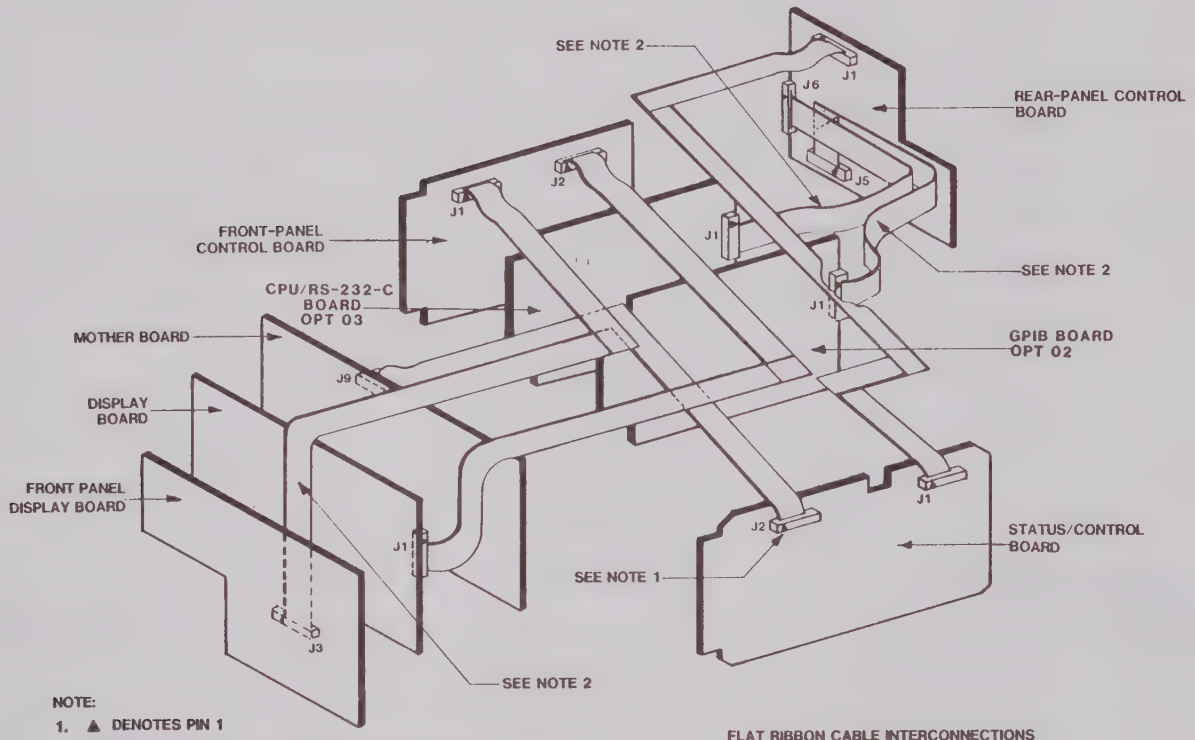
1. Remove the two slot-head screws from the filter holder and remove the holder and sponge-rubber filter.
2. Use a vacuum cleaner to clean the filter.
3. Reinstall the filter and holder and secure with the two screws.

8.4 GENERAL TROUBLESHOOTING

WARNING Hazardous voltages exist in this equipment. Stay clear of all line-voltage wiring and terminals.

Board and Connector Seating

Be sure all printed circuit boards are securely seated in their connectors. Be sure the hold down bracket is tightly secured. Be sure interconnecting ribbon cables are properly secured as shown in the drawing.

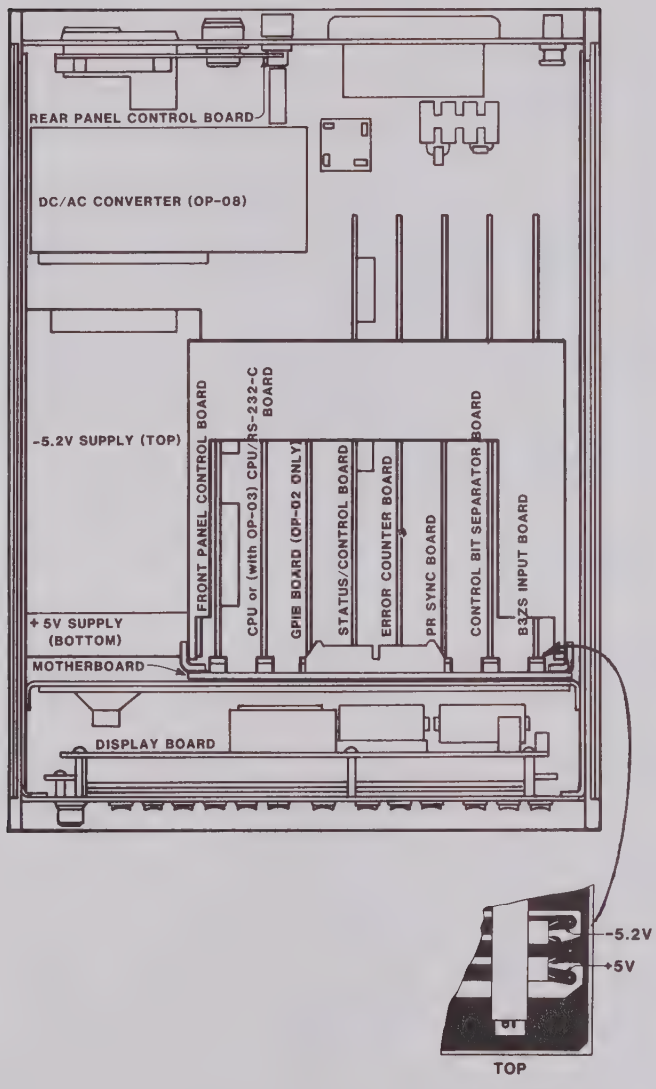


FLAT RIBBON CABLE INTERCONNECTIONS

DC Voltages

Check the power-supply outputs as follows:

+5V ±0.2V
-5.2V ±0.2V



Nicad Battery

A 1.2V Nickel Cadium battery pack is used in the transmitter to preserve front-panel settings in case of a power failure. If the battery is discharged or disconnected, the front-panel power up conditions will be incorrect.

Visual access to the battery pack may be gained by removing the top cover.

The battery type is General Electric KØ1H111C-GT1.

8.5 SOFTWARE DIAGNOSTICS

Software diganostics perform basic tests at power-up and during normal operation. If a power-up test fails or an illegal condition occurs (i.e., more errors than bits, more error-seconds than seconds, etc.) the software displays a failure message on the front-panel display of the form:

```
* * * * *  FAILURE: A=nn (SP)=XXXX
```

Where: nn is the failure code, and
XXXX is the program address of the failure

An internal DIP switch or jumper plug on the Status and Control board (see Section 7.6 f theory of operation of the Status and Control board) determines whether the software will halt or attempt to restart after displaying the failure message.

The following tables list failure codes that can be directly correlated to hardware failures. Other codes exist and may be displayed but they have no correspondence to specific hardware problems nor do the program addresses.

8.5.1 **POWER-UP FAILURE MESSAGES**

Failure Code A=	Meaning
00 or 08	U5 (S001 PROM) bad on Front-Panel Control board or failure accessing PROM; addresses 0000 thru 07FF.
10	U2 (S002 PROM) bad on Front-Panel Control board or failure accessing PROM; addresses 0800 thru 0FFF.
18	U6 (S003 PROM) bad on Front-Panel Control board or failure accessing PROM; addresses 1000 thru 17FF.
20	U13 (S004 PROM) bad on Front-Panel Control board or failure accessing PROM; addresses 1800 thru 1FFF.
28	U17 (S005 PROM) bad on Front-Panel Control board or failure accessing PROM; addresses 2000 thru 27FF.
30	U23 (S005 PROM) bad on Front-Panel Control board or failure accessing PROM; addresses 2800 thru 2FFF.
38	U13 (S007 PROM) bad on Status and Control board or failure accessing PROM; addresses 3000 thru 37FF.
40	U14 (S008 PROM) bad on Status and Control board or failure accessing PROM; addresses 3800 thru 3FFF.
48	U15 (S009 PROM) bad on Status and Control board or failure accessing PROM; addresses 4000 thru 47FF.
50	U16 (S010 PROM) bad on Status and Control board or failure accessing PROM; addresses 4800 thru 4FFF.
58	U15 (S026) PROM bad on GPIB board (OP-02 only) or failure accessing PROM; addresses 5000 thru 57FF.
60 thru 63	U9 or U10 (RAMs) bad on Status and Control board or failure accessing RAM; addresses 6000 thru 63FF.
64 thru 67	U22 (RAM) bad on Status and Control board or failure accessing RAM; addresses 6400 thru 67FF.

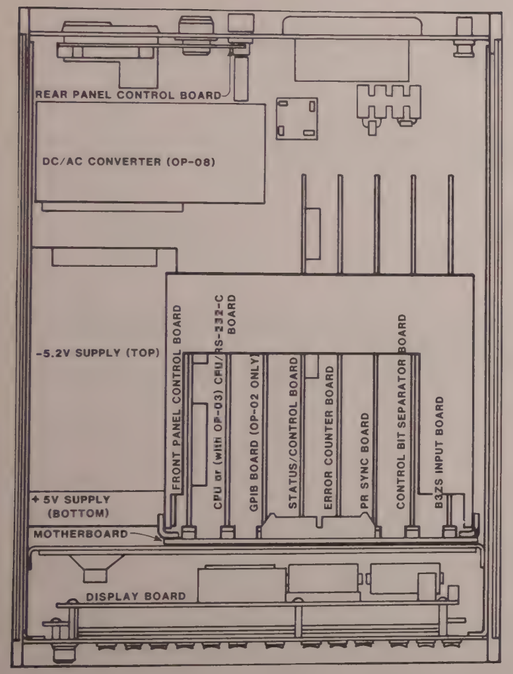
68 thru 6F U12 (RAM) bad, on GPIB board (OP-02 only) or failure accessing RAM; addresses 6800 thru 6FFF.

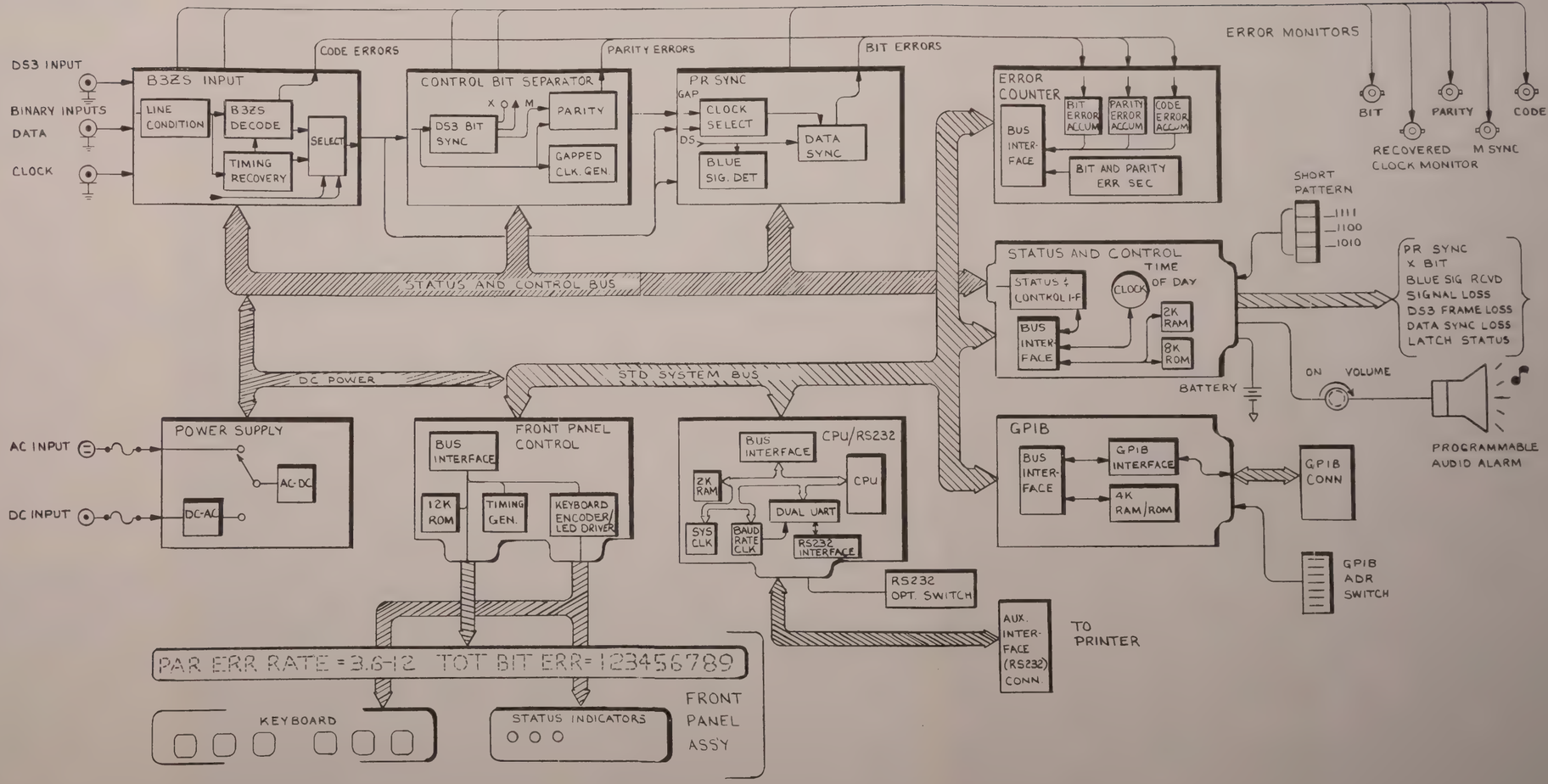
F8 thru FF U11 (RAM) bad on CPU board or CPU/RS-232-C board (OP-03) or failure accessing RAM; addresses F800 thru FFFF. Mostek CPU installed but DIP switch or jumper plug on Status and Control board improperly configured. U23 (RAM) on Mostek CPU board bad or failure accesing RAM; addresses FF00 thru FFFF.

8.5.2 ON-LINE MONITORING FAILURE MESSAGES

Code A=	Meaning
47	Invalid short-pattern code because of failure reading rear-panel Short-Pattern switch or Ribbon cable not connected or Status and Control board failure or Rear-Panel Control board failure.
4D, 4E, 50	Invalid BIT/PAR error counts because of failure reading Error Counter board or other failure in high-speed boards.
51	Parity error-second indicator set twice in less than one second because failure in parity error-second circuitry on Error Counter board.
52	Bit error-second indicator set twice in less than one second because of failure in bit error-second circuitry on Error Counter board.

Section 9, Diagrams





Tau-Tron
form
0161-0582D
S5200D-RX
1 of 1
BLOCK

Repair Returns

To return a unit for repair:

1. Call the Customer Service Dept. **(617) 692-5100** or **1-800-TAU-TRON (outside MA)**, for a **Repair Authorization Number.** This will reduce administrative delays and ensure prompt return of your unit.
2. Complete and **attach one of the Repair Tags** below to your unit.
3. **Pack the unit** in the original shipping carton and packaging materials, if available. Otherwise use a double-walled carton (test strength of 350 lb) and shock absorbing material such as bubble wrap to prevent the unit from moving in the carton during transit. Seal with heavy paper tape.
4. **Send to:**

   Tau-tron
   10 Lyberty Way
   Westford, MA 01886
   attn: Customer Service

Repair Tag

Repair Authorization Number _____

Model _____ Serial Number _____

☐ Warranty repair ☐ Dead on arrival ☐ Repair ☐ Modification ☐ Recalibration

Symptoms: _____

_____

Name _____ Title _____

Company _____ Dept./MS _____

Address _____ City _____

State&Zip _____ Phone _____

Form 0163-1181A

Repair Tag

Repair Authorization Number _____

Model _____ Serial Number _____

☐ Warranty repair ☐ Dead on arrival ☐ Repair ☐ Modification ☐ Recalibration

Symptoms: _____

_____

Name _____ Title _____

Company _____ Dept./MS _____

Address _____ City _____

State&Zip _____ Phone _____

Form 0163-1181A

Your Feedback is Important

In fact it's necessary to help us produce an instruction manual that meets your needs. If you have any suggestions, corrections, or questions, we'd like to hear from you.

If you have any feedback, please complete, detach, and mail the lower card

If you would like a representative to call, require additional information, or would like to be placed on our mail list to receive **The Pulse** or other useful technical information, please complete, detach, and mail the card below.

Please—

☐ Have representative call.

☐ Add me to your mailing list.

Send additional information on:

☐ Bit Error Rate Testing
☐ TDM Voice/Data Multiplexers
☐ Digital Transmission Test Sets
☐ Fiber Optic Transmission
☐ Data Loggers
☐ High Speed Components

My general application is _____

Name _____ Title _____

Company _____ Dept./MS _____

Address _____ City _____

State & Zip _____ Phone _____

Instruction Manual Form Number ☐☐☐☐☐-☐☐☐☐☐

Comments _____

from:

Name _____ Title _____

Company _____ Dept./MS _____

Address _____ City _____

State & Zip _____ Phone _____

Form 0159A 0884D

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Westford, MA 01886

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